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HISTORICAL EVIDENCE AS TO THE ORIGIN OF THE PAIRED LIMBS OF VERTEBRATES.

BASHFORD DEAN.

WHATEVER be the results of embryologists, the real test of the problem of the mode of origin of the paired limbs of vertebrates belongs obviously to paleontology. For if the paired limbs, as most morphologists believe, arose as highly specialized lappets of a continuous lateral skin fold, it is quite evident that sooner or later these conditions will be demonstrated convincingly among the earlier fossil fishes. In point of fact, the paleontological evidence bearing upon this matter is of such great value, even at the present time, that we can justly regret that it has received scanty attention at the hands of embryologists. It is indeed so imperfectly noticed in the recent voluminous papers which bear upon the general problem of limb origin that I have been led to the following comments.

I. THE WEIGHT OF EVIDENCE.

If we accept the general rule that earlier forms are of greater value for purposes of determining primitive characters than are later ones, and if we admit that a study of many genera and

many species is of greater value than an examination of few specimens of few species, we must, I believe, conclude that the doctrine of the origin of the paired limbs from lateral dermal folds rests upon strong foundations. Reducing to simplest terms our knowledge of the earliest sharks or shark-like fishes, among which the ancestral jaw-bearing vertebrates are reasonably sought, we find that of forty odd species, representing fifteen genera (Paleozoic), whose fin characters are known, all but those of a single genus, and possibly a second, are distinctly in favor of the lateral-fold theory. And the exceptions to the rule are the most recent forms and in important structural regards the least primitive.

More concretely, such genera as the Upper Silurian and Lower Devonian Parexus (two species), Climatius (eight species), Diplacanthus (five species) (= family Diplacanthidæ), Cheiracanthus (three species) (Acanthodidæ), and the long-enduring Acanthodes (twelve species) (Lower Devonian to Permian); as the Upper Carboniferous Acanthodopsis (but we may put the last aside, since its fin structures are not as well known as in the neighboring forms); as the Permian Protacanthodes and Traquairia, — all of these ancient sharks have their paired limbs in the form of distinct longitudinal skin folds, and these paired fins, furthermore, are essentially similar to the unpaired ones. This conclusion is based upon numerous and well-preserved specimens. The next ancient sharks whose fin structures are described are the (now accepted as) Upper Devonian cladoselachids (about two genera and six species). These have the paired fins extended along the body, their hinder web narrowing gradually and merging with the body wall, showing no trace of a lobate fin base projecting from the body. Here, too, the paired fins closely resemble the unpaired fins. Structural details in these forms are known from a score or more of well-preserved specimens. A kindred Upper Devonian shark is Ctenacanthus, whose fin structures have hitherto been unknown; but an interesting specimen of this form, showing pectoral fins and spine *in situ*, has now been discovered, and it shows convincingly that this shark had a fin-fold type of fin. Its radials pass to the margin of the fin, as in Cladoselache,

each with a corresponding basal; unlike cladoselachids, there are no intercalated rays. Next ancient is Traquair's specimen of Cladodus (Lower Carboniferous) (*cf.* Fig. 1), whose pectoral gives evidence of a line of basal plates extending backward like

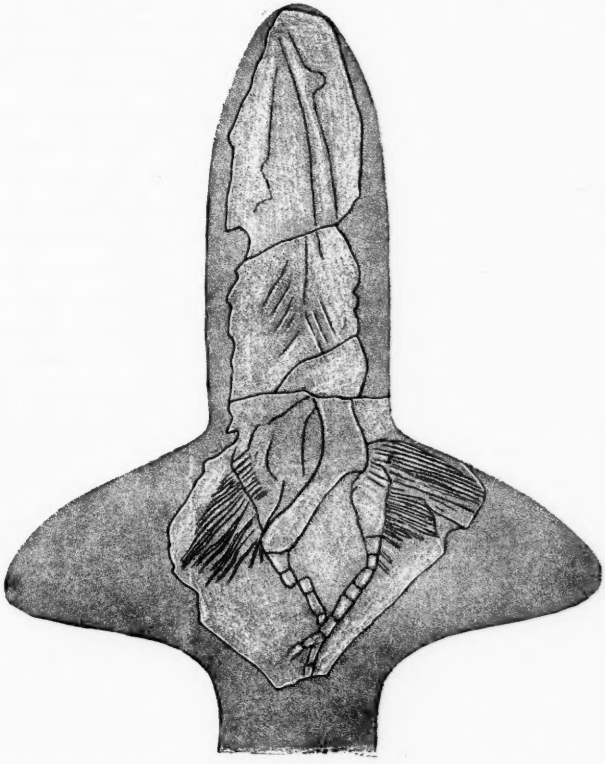

FIG. 1. — The Paleozoic shark *Cladodus neilsoni* Traquair. The fossil is shown surrounded by the outline of a specimen of Cladoselache of similar size, — indicating that the fins of Cladodus were of larger size than the present fossil suggests.

a rayless axis of an "archipterygial" fin. This specimen has been taken in evidence of the non-primitive nature of the fin-fold type of limb (*vide infra*). Last of the ancient forms are the Permian symmoriids and xenacanthids. Of these Symmorium, judging from the single fragmentary pectoral described

by Cope, is similar to cladoselachids, but remarkable in that its hindmost rays apparently coalesce at their bases so as to form a stout supporting plate. There is no evidence, however, that this projected from the body wall, nor have we any knowledge of pelvic or unpaired fins. In xenacanthids, on the other hand, many and well-preserved specimens (of two or three species) show a biserial archipterygium in the pectoral fin, and this condition has been the main paleontological stay of those who oppose the fin-fold hypothesis. They lay no emphasis, however, on the late appearance of this form (for there is no evidence forthcoming that the Coal Measure "Xenacanthus" had fins like the Permian form), or on the facts that its ventral fin is *not* a biserial archipterygium but resembles closely the unpaired fins immediately behind it, and that this form has already developed a mixipterygium, and has specialized an amphistylic attachment of jaw to skull, and that it has largely lost its integumental defenses.

Balancing the matter fairly, I think that we must conclude that the weight of the evidence of Paleozoic sharks falls emphatically on the side of the longitudinal fin-fold hypothesis. Indeed the only way, as far as I can see, in which this evidence can be denied is by a frank rejection of the well-accepted view as to the primitive nature of the earliest elasmobranchs (Proselachii).

II. THE FIN-FOLD CHARACTER OF THE EARLIEST FORMS, ACANTHODIANS AND CLADOSELACHIDS.

The dermal-fold nature of the paired fins of the acanthodians requires little comment. Excepting in a brief note of Dr. Fritsch,[1] no attempt has ever been made to explain them in accordance with the theory of Gegenbaur; that is, that their origin is due to outgrowth of elements belonging to serially homologous gill bars. Continuous fin folds they certainly are,

[1] *Fauna d. Gaskohle Formations Böhmens* (1893, p. 71), in which the spine is regarded as the archipterygium. Dr. Jaekel homologizes shoulder girdle to gill arch, but does not consider the relations of the fins themselves. *Verhandl. Deutschen Zool. Gesell.* (1899), pp. 256–258.

whether or not we accept the origin of their supporting elements as equivalent to the coalesced radial supports of a more typical shark-like fin. On the other hand, the paired fins of the cladoselachids are distinctly shark-like, although in pattern unlike those of later selachians. They are remarkable in that they are built on the plan of balancing organs; *i.e.*, the fin was attached keel-fashion, along the side of the body, and probably functioned by means of ventrad and dorsad movements (undulatory at fin margin ?). And the blade of the fin could not be rotated (twisted) sideways. This is attested structurally by (1) its graded series of radials, — larger, most numerous, and most crowded in the anterior region; (2) by the absence of a metapterygial lobe, and in the continuation of the fin web hindward along the margin of the body; physiologically (3) by its close analogy with the dorsal and anal of such a form as Mola, in which we know that this undulatory movement has been specialized. That the paired fins of Cladoselache, moreover, cannot be interpreted as "due to bottom living" on the plan, *e.g.*, of Rhina, becomes clear when we consider that the radial cartilages are unjointed throughout their length, that the ventral and pectoral fins are not drawn together in a ray-like way, and that the fins, in spite of their remarkable character, are *as small in proportion to the size of the body as those of modern selachians* (Pristiurus, Scyllium), *which are known to be free swimming.* (*Cf. Natural Science*, Vol. VIII (1896), pp. 250–252, and *Anat. Anzeiger*, Bd. XI, pp. 673–679. *Vide* also *infra.*)

III. The Evidence of Paleontology as to the Development of the Unpaired Fins.

In recent work tending to support the hypothesis of Gegenbaur no reference is made to the mode of origin of the unpaired fins. This, we must grant, would have an important bearing upon the problem of the extremities if evidence existed to show that in a late stage in the evolution of the unpaired fins an archipterygium arose, like that of the paired fins. As a matter of fact, paleontology demonstrates that such a condition

is represented in the case of the ancient ganoids (crossopterygians); for in certain Devonian forms (*cf.* also Mesozoic genera) the dorsal fins show clearly concrescence of radial and basal elements in a way which parallels strikingly the biserial archipterygium (of the paired fins).[1] This condition, although well known to the paleontologist, appears to have escaped the notice of the adherents to the Gegenbaurian school. It is perfectly evident that if the biserial archipterygium arises in the unpaired fin from the concrescence of lateral fold-like supporting elements, the similar structure in the paired fins must have arisen in a similar way, or, to say the least, the burden of disproof lies with those who believe that such closely similar structures arose by diametrically opposite processes.

IV. CONCLUSION.

The evidence of Paleozoic sharks, then, is most distinctly in favor of the Thacher-Balfour teachings. The oldest forms, acanthodians and cladoselachids, represented by the best-preserved fossils present lateral-fold fins. Moreover, there is evidence that as the series advances from the Lower Devonian, the structures of the biserial archipterygium are gradually acquired. The Carboniferous *Cladodus neilsoni*, Fig. 1, of Traquair shows for the first time a definite segmentation of the supporting elements of the base of the pectoral fin.[2] Then in the Permian Symmorium Cope, the fin bases not only are formed, but show apparent fusion in the metapterygial region, and even perhaps an extension from the body wall of the metapterygial terminal, a condition which would be best correlated with a change of function in the fin. And finally, in the xenacanthids, whose structures are known only in this later horizon, the pectoral fin acquires a biserial archipterygium. The conditions, however, of *Cladodus neilsoni* and of Symmorium

[1] *Cf.* also the anals of Xenacanthus.

[2] Judging from the size of the shark and the character of the radials, the pectoral fin was probably larger, and there is thus ground to believe that the posterior radials of the fin have been lost. This is better understood by reference to the accompanying Fig. 1, where the Scottish specimen is shown overlaid with an outline of Cladoselache of similar size.

are still doubtful, the present knowledge of them having been based upon single, imperfectly preserved, and fragmentary specimens. The conditions in Cladoselache, on the other hand, are known from upward of thirty specimens, some of which are admirably preserved.[1] In conclusion, if the Gegenbaurian adherents are to contest the sum and substance of the paleontological evidence, they have, it seems to me, the difficult task of demonstrating (1) that acanthodians, the most extensive group of Paleozoic sharks, do not possess pleuropterygia; (2) that Cladoselache, in spite of its earlier occurrence and peculiar structures, is not as archaic a type of shark as Xenacanthus; and (3) that the "archipterygium" formed in the unpaired fins as the terminal member of a series whose original structures were of fin-fold character, is formed in exactly the opposite way from the archipterygium in the paired fin. Until these contradictions have been disposed of, no evidence based upon recent forms can, I believe, attack the main trenches of the lateral-fold theory.

Postscriptum. — Objections which have been urged to the foregoing conclusions.

As far as I am aware, no objections have been raised to the conclusion that the paired fins of the acanthodians represent definite lateral dermal folds, whatever may be regarded as the homologues of the supporting elements of these fins. (Thus Fritsch endeavors to find in the pulp canals of the anterior fin spines rudiments of an entire biserial archipterygium (*Fauna d. Gaskohle Formations Böhmens*, Bd. III, p. 71). (As a corollary to this suggestion, I take it, the fin spines of *all* acanthodian fins are equivalent to archipterygia, since the spines are similar in structure in all fins!) Cladoselache, however, has been subjected to adverse criticism by several advocates of Gegenbaur's hypothesis. Professor Jaekel, the first of these critics, is the only one who appears to have had the opportunity of examining actual specimens of this form, for during his visit to

[1] Sections of the muscle plates have been found to show transverse striæ in the fossilized muscle cells. Their description will shortly be published.

New York he inspected some of the material obtained by Professor Newberry for the museum of Columbia University. He regarded "Cladodus" as a shark which had become highly specialized and adapted to bottom living. Against this view it is merely necessary to note that Cladoselache possessed dorsal fins, one of which was situated well forward on the trunk region, its anterior rim lying above the pectoral fin, a condition entirely unknown in any depressed type; that the caudal fin was of a peculiar form, extreme in its heterocercy, and provided on either side with broad, stout lateral flanges closely comparable to those of such swift-swimming forms as Isurus, or even scombroid fishes. It is evident that none of these characters can be associated with a bottom-living form such, for example, as Rhina. Moreover, *if Cladoselache were a bottom-living form, its fins would obviously have been larger in proportion to the size of the animal than those of recent sharks.* In this connection, however, it is only just to Dr. Jaekel to state that at the time of his visit to Columbia University none of the best material of this form had yet been obtained, — that the caudal and dorsal fins, for example, were not known.

A second writer, Professor Semon, in one of his studies on Ceratodus (*Forschungsreisen*, Bd. I (1898), pp. 105–106), subscribes to a page of general denial as to the primitive nature of Cladoselache. As he does not, however, refer to the detailed literature upon this form, quoting only from a single and semi-popular article, and in view of other omissions, I am inclined to believe that his criticism is inadequate. Thus I note that he is unaware that the horizon of Cladoselache is now conceded (*cf.* Orton and others) to be Upper Devonian instead of Lower Carboniferous, and that he puts this form in the Coal Measures side by side with xenacanthids, whose structural characters are known only from the Permian; also that he states that *dipnoans* (he does not mean by "dipnoans," I take it, the very problematical arthrodires, since these are naturally included in the term "placoderm," which he specifically mentions) *and crossopterygians were already present in Silurian times,*—a statement I can only account for on the basis either that he has collected data which, when published, will throw light upon this empty page of the geological

record, or that by Silurian he means Devonian, an age in which, by the way, we must admit that Cladoselache occurs. He surely cannot refer in the above terms to the minute fragments of Ostracophores of Oesel, which were once, about a decade ago, referred to as ganoidean and dipnoan.

And most recently Dr. Braus[1] has considered in a special paper the later discoveries in fin structures in fossil selachians, and has even concluded that "through paleontology the theory of Gegenbaur has been given new life." Braus, however, makes no reference in this connection to the archipterygial characters of unpaired fins, nor yet to acanthodians, and furthermore, he treats all extinct forms without reference to their different geological horizons. The pectoral fin of Cladoselache he regards as essentially similar to that of Chlamydoselachus, believing that its metapterygial region has been obscured by the overlying body wall during the process of fossilization, and that the fin in reality possessed a lobate base which projected from the body wall, as in the recent shark. He accordingly must believe that the continuous posterior dermal margin of the fin in the fossils, as several writers have figured it,[2] is not a just one. I think, however, that I am justified in stating that this reactionary view finds no support in any known[3] specimen of this form. And I may further add that the line which continues the web of the lappet-shaped fin along the side of the body, which Braus is skeptical about, and which is hostile to the Gegenbaurian theory, is preserved in faultless condition in as many as a dozen specimens which are now under my hands. Braus further believes that the ventral fin of Cladoselache shows a trace of a distinct metapterygium (as of Chlamydoselachus), inasmuch as radials occur in the hinder portion of the fin web,

[1] *Verhandlungen d. Phys.-Med. Gesellsch. zu Würzburg* (N.F.), Bd. xxxiv (1901), pp. 177–192; *cf.* also *Zool. Forschungsreisen*, Bd. i (1901), Lieferung III, pp. 197, 266, 268.

[2] The fin margin has thus been figured — rounding in along the body wall — undissentingly by at least four authors. Braus does not consider this important feature of the fin, which I am sure he would have felt bound to do had he examined actual specimens.

[3] I speak confidently, since I have good reason to believe that all cladoselachids have hitherto been obtained through three collectors in Ohio, whose output I have had the opportunity of examining.

a conclusion to which I do not understand the *sequitur*. The absence of mixipterygium in cladoselachids (as well as in acanthodians, in fact the whole matter of the acanthodians) he does not consider in this connection.

Braus, in summary, teaches that paleontological discoveries lead to the "overwhelming conclusion" that the recent shark fin has acquired its typical form of skeleton through a process of reduction wherein the original terminal and post-terminal axial portions have become lost, while the pre-axial region has developed and with it its basal plates. The reviewer, however, must confess that he finds it rather difficult to determine exactly how Braus has obtained these paleontological results, unless by deriving the Devonian forms from the Permian ones, — which, in view of the many remarkable structural characters of Cladoselache (which Braus also, by the way, does not consider), appears as unconvincing as a process which derives the Miocene Protohippus from the Pliocene horse.

RECENT INVESTIGATIONS UPON THE EMBRYO SAC OF ANGIOSPERMS.

DOUGLAS HOUGHTON CAMPBELL.

THE development of the embryo sac of the angiosperms has engaged the attention of many botanists from Hofmeister on, and the homologies of its parts have been widely discussed. All of the earlier researches seemed to indicate an extraordinary uniformity in the structures of the embryo sac, very few deviations from the type being noted, and the importance of these variations being frequently ignored.

With the improved histological methods developed in recent years there has been a renewed interest in the subject. The important paper by Treub on Casuarina[1] called attention to several striking deviations from the ordinary angiospermous type. This paper was followed by a long series of investigations by many botanists both at home and abroad, which have extended materially our knowledge both of the morphology and physiology of the embryo sac.

The uniform results of the earlier investigations may be explained, in part at least, by the selection of the more specialized forms for study. These would naturally conform, for the most part, to the structure characteristic of the embryo sac of the typical angiosperms. The more generalized and presumably more primitive forms were neglected, and the significance of such important variations as the largely increased number of antipodal cells in many grasses was usually overlooked. So great, indeed, was the uniformity assumed to be, that all efforts to explain the origin of the angiosperms from lower forms was considered well-nigh hopeless.

The studies of the last dozen years have shown that there is much more deviation from the type than was supposed to be the

[1] Sur les Casuarinées et leur place dans le système naturel, *Annales du Jardin Botanique de Buitenzorg*, tome x, pp. 143–231. Leyden, 1891.

case, and these have encouraged further researches upon the simpler types of angiosperms. Some of these have yielded interesting results, and already give some hints of the possible origin of the structures of the angiospermous embryo sac.

While it cannot be said that this very important point is likely to be explained satisfactorily in the near future, nevertheless it can be said that not unimportant advances have been made, and the purpose of this sketch is to bring together the most noteworthy results of these recent investigations, and to indicate their bearing upon the question of the origin of the angiosperms.

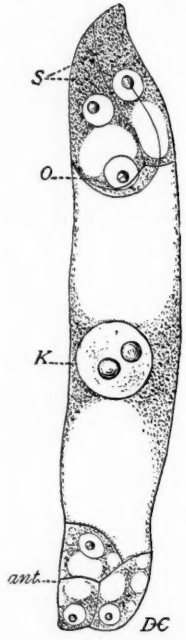

FIG. 1. — Embryo sac of *Monotropa uniflora*. At the micropylar end is the egg apparatus, consisting of the egg, *o*, and the two synergidæ, *s*; at the chalazal end, the three antipodals, *ant.*; the endosperm nucleus, *k*, still shows the two nucleoli of the polar nuclei of which it is formed.

In the great majority of investigated angiosperms the embryo sac, as is well known, exhibits extraordinary uniformity in its structure. In most instances the embryo sac arises from a subepidermal cell (Fig. 2 A), which may either develop at once into the embryo sac, or, as is more commonly the case, it divides into several cells, one of which becomes the embryo sac.

With the first division of the nucleus of the young embryo sac, the polarity which is so marked a feature becomes established. Of the two nuclei resulting from the division of the primary nucleus, one moves to the apical (micropylar) end of the sac, the other to the basal (chalazal) end. Two nuclear divisions follow, resulting in four micropylar and four chalazal nuclei. From each of these groups one nucleus, the polar nucleus, moves toward the center of the sac, where it unites with the corresponding nucleus from the opposite end. The three remaining apical nuclei, with their accompanying cytoplasm, constitute the egg apparatus; the three basal ones,

which usually become surrounded by definite cell membranes, form the three antipodal cells. The polar nuclei, either before or after fertilization, fuse to form the primary endosperm nucleus.

The most marked deviations from the typical development observed by the earlier investigators were an increase in the number of archesporial cells (Rosa *sp.*, Helleborus, etc.) and an increase in the number of antipodal cells. Of the latter variations the most marked examples were various species of grasses, first noted by Hofmeister. Further examples of both of these

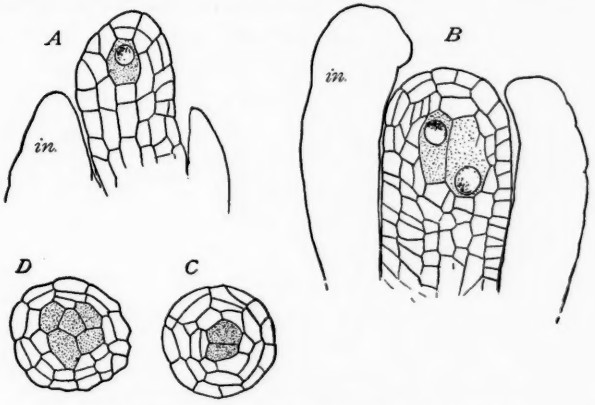

FIG. 2.—Ovules of *Arisæma triphyllum*: *A*, *B*, in longitudinal section; *C*, *D*, transverse sections of the nucellus; the archesporial cells are shaded.

deviations from the type have been recorded by later investigators, and other modifications, not hitherto observed, have been discovered.

The departures from what may be termed the typical development may be referred to several categories. Besides those already referred to, these are three in number: (1) an increase in the number of nuclei before fertilization has taken place; (2) peculiarities in the formation of the endosperm; (3) the so-called double fertilization.

The increased number of archesporial cells observed by Strasburger in *Rosa livida*, *Helleborus cupreus*, and other forms,[1] has been found to occur in a considerable number of forms.

[1] Goebel. *Outlines of Morphology*, etc.

Treub describes a large number of sporogenous cells in Casuarina, several developing into complete embryo sacs. The multicellular archesporium in this case is comparable to that of the pteridophytes and gymnosperms. This increase in the number of sporogenous cells is seen in a lesser degree in *Arisæma triphyllum* (Fig. 2). In the latter the original hypodermal archesporial cell divides longitudinally into 2–4 (occasionally more). One of these, as a rule, becomes at once the embryo sac, but sometimes there are first transverse divisions. It is possible that there may sometimes be more than one primary archesporial cell in Arisæma, *i.e.*, the whole sporogenous tissue may not certainly be referable to the division of a single hypodermal cell. This point, however, needs further investigation.

CASUARINA.

The very peculiar genus Casuarina, according to Treub's investigations,[1] differs decidedly from the other angiosperms, not only in the large development of the sporogenous tissue of the ovule, but also in the structure of the developed embryo sac. This has no antipodal cells, and all the cells of the egg apparatus, which are variable in number, are formed from the division of a primary cell. The egg, moreover, is surrounded by a cellulose membrane before fertilization takes place, a condition unknown among other angiosperms. Before the egg cell divides (and Treub believes before it is fertilized) there is a rapid increase in the number of endosperm nuclei. A demonstration of the actual fertilization was not made, and this point must remain for the present in doubt. Should it be verified, it might well be compared with the condition existing in Peperomia.

PEPEROMIA.

In the genus Peperomia the writer[2] found that there is normally a doubling of the nuclei of the embryo sac before fertilization; *i.e.*, instead of the eight nuclei usually found in the mature embryo sac, there are sixteen (Fig. 3). This fact

[1] *Loc. cit.*

[2] Campbell. The Embryo Sac of Peperomia, *Annals of Botany*, vol. xv (March, 1901), pp. 103–118.

was confirmed by Johnson,[1] who also discovered that the endosperm nucleus was the product of the fusion of several nuclei, instead of two, as in the typical angiosperms. In Peperomia there is no clearly defined egg apparatus, nor are there any proper antipodal cells, although a varying number of nuclei become enclosed in cell membranes and form small flattened cells applied to the wall of the embryo sac. It is to be hoped that a further study of the embryo sac of Casuarina may be made, employing carefully stained microtome sections. A comparison with the embryo sac of Peperomia would be of great interest.

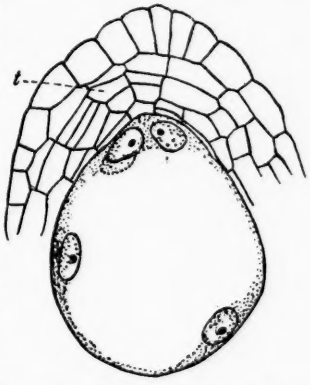

FIG. 3. — A nearly medium longitudinal section of the embryo sac of *Peperomia pellucida*: there were present sixteen free nuclei, of which six are visible in this section.

The increased number of nuclei in the embryo sac of Peperomia, while intermediate in character between that of the typical angiosperms and the lower vascular plants, might equally well be compared with that of the gymnosperms or the heterosporous pteridophytes. The nearest approach to it is found in Gnetum,[2] where the structure is not dissimilar, no true archegonium being present, but the egg cell being developed from one of the free nuclei. However, as the affinities of Gnetum are very obscure, this resemblance does not necessarily imply any connection between Peperomia and the typical gymnosperms.

An increased number of nuclei in the unfertilized embryo sac has been recorded as an occasional variant in several low monocotyledons, — *e.g.*, Naias, Zannichellia, Sparganium, — but in all these forms the normal embryo sac is of the ordinary angiospermous type.

[1] Johnson. On the Endosperm and Embryo of Peperomia pellucida, *Botanical Gazette*, vol. xxx, July, 1900.

[2] Lotsy. Contributions to the Life-History of the Genus Gnetum, *Annales du Jardin Botanique de Buitenzorg*, tome xvi (1899), pp. 46–114.

Karsten. Beiträge zur Entwickelungsgeschichte der Gattung Gnetum, *Botanische Zeitschrift*, Bd. l, 1892.

VARIATION IN THE ANTIPODAL CELLS.

The three antipodal cells commonly found at the chalazal end of the embryo sac are frequently looked upon as merely vestigial structures, as in many cases they doubtless are. That they may be of importance physiologically has been

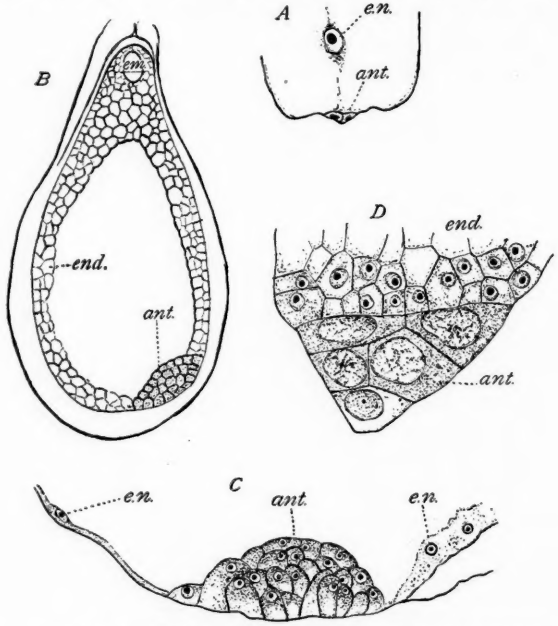

FIG. 4. — *A*, the chalazal end of the embryo sac of *Sparganium simplex*, about the time of fertilization: *e.n.*, endosperm nucleus; *ant.*, two of the three antipodal cells. *B*, section of a young seed of the same species: *em.*, embryo; *end.*, endosperm; *ant.*, the large mass of antipodal cells. *C*, antipodal cells and young endosperm from a somewhat earlier stage, more highly magnified. *D*, chalazal end of the embryo sac from a young seed of *Lysichiton kamtchatcense*, showing endosperm, *end.*, and the enlarged antipodal cells, *ant.*

repeatedly shown, and there is no question that this is oftener the case than was formerly supposed. In many forms — *e.g.*, Naias, Lilæa — the antipodal cells are large, with abundant cytoplasm, and every indication of being active cells. In other cases, such as some Ranunculaceæ,[1] they become very large,

[1] Mottier. Contributions to the Embryology of the Ranunculaceæ, *Botanical Gazette*, vol. xx, 1895.

and become multinucleate. An increase in the number of antipodal cells was observed as a regular phenomenon in various grasses, by Hofmeister, and has been noted also by later observers, — Cannon[1] found in *Avena fatua* as many as thirty-six. There are in these cases the original three antipodals which subsequently increase by division, this occurring before the egg is fecundated.

The greatest number of antipodal cells yet recorded occurs in *Sparganium simplex* (Fig. 4), where there may ultimately

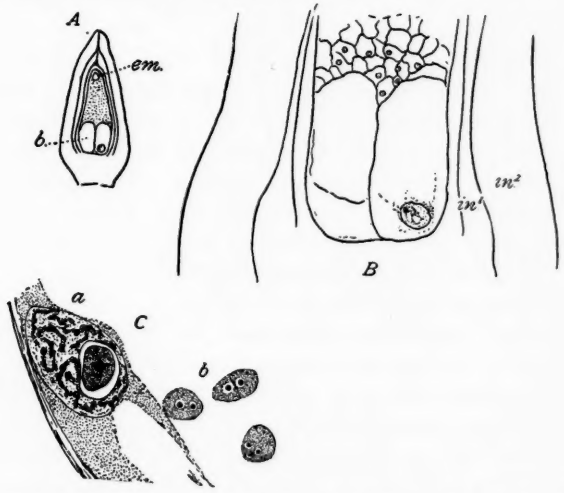

FIG. 5. — *A*, section of young seed of *Spathicarpa sagittæfolia*: *em.*, embryo; *b.*, enlarged basal endosperm cells, × 6. *B*, basal portion of the embryo sac of the same, more enlarged. *C*, the large basal endosperm nucleus, *a*, and the ordinary ones, *b*, from the embryo sac of *Naias flexilis*.

be 150 or more. At the time of fertilization there are but three, small and inconspicuous antipodal cells; but after fertilization these increase rapidly in size and begin to divide actively, forming a very conspicuous hemispherical mass of cells at the base of the embryo sac. This large group of antipodal cells develops while the endosperm is still rudimentary and is doubtless of great physiological importance.

[1] Cannon. A Morphological Study of the Flower and Embryo of the Wild Oat, *Proc. California Acad. of Sciences*, third series, vol. i, No. 10, 1900.

Among other similar cases may be mentioned that of the peculiar aroid, Lysichiton, which occurs upon the northern shores of the Pacific. The original antipodal cells divide in this case also, and their nuclei become enormously enlarged (Fig. 4 *D*).

From a study of the numerous instances which have been studied, it is clear that the antipodal cells are by no means merely vestigial structures, but are often of great physiological importance, replacing the endosperm to some extent, or acting as a medium for the transport of nutriment to the developing embryo.

THE ENDOSPERM.

In the typical angiosperms the primary endosperm nucleus resulting from the fusion of the polar nuclei divides to form many free nuclei lying in the peripheral layer of cytoplasm. Walls form between these nuclei, and a layer of tissue is thus developed, lining the embryo sac. By subsequent centripetal divisions the embryo sac becomes finally completely filled with endosperm. When the embryo ultimately fills the whole embryo sac the cell divisions in the endosperm may be entirely suppressed (*e.g.*, Naias). In other cases the first division of the primary endosperm nucleus is followed by a cell wall extending across the cavity of the embryo sac, which is thus filled from the first with tissue.

A modification of the type has been noted in a number of low monocotyledons. Of the two nuclei resulting from the division of the primary endosperm nucleus, only the upper one divides further. The lower one, which may be separated by a wall from the upper part of the embryo sac,[1] sometimes becomes enormously enlarged (Fig. 5 *C*) but does not divide further. It is possible, although this has not been demonstrated, that in some cases there is no fusion of the polar nuclei.

A condition somewhat intermediate between the ordinary form and that just described was recently observed by the writer in *Spathicarpa sagittæfolia*, a South American aroid. In this case (Fig. 5) a group of a few very large cells, with

[1] Schaffner. The Life History of Sagittaria variabilis, *Botanical Gazette*, vol. xxiii, 1897.

enormous nuclei, lies at the base of the endosperm and is sharply separated from the small-celled endosperm in the upper part of the embryo sac. It is probable that the basal group of large cells is the product of the lower of the two nuclei derived from the first division of the endosperm nucleus.

In the genus Peperomia the very large endosperm nucleus is the result of the fusion of several (usually eight) nuclei. It then divides to form the rudimentary endosperm found in the ripe seed.

Double Fertilization.

Much interest has been aroused by the discovery of the so-called double fertilization which has been demonstrated for a large number of angiosperms. This double fertilization consists in the fusion of the second generative nucleus of the pollen spore with the endosperm nucleus, which thus becomes the product of three nuclei. This has led to a theory that the endosperm nucleus is sexual in its nature, and the endosperm arising from it is an embryo. That this view can hardly be maintained is evident from the condition found in Peperomia, which presumably represents a more primitive condition than that of the typical angiosperms. In Peperomia, as already stated, the endosperm nucleus is the product of several similar nuclei, and as such a multiple fusion of sexual cells is quite unknown elsewhere, it is safe to assume that this fusion is not of the nature of a true fertilization.

That the second generative nucleus discharged into the cavity of the embryo sac should fuse with the only available nucleus, the endosperm nucleus, is not surprising. That its character is impressed upon the resulting nuclei is also to be expected. This is shown most clearly in the case of hybrid maize. It has been clearly demonstrated that one type of maize pollinated with another will produce ears in which the endosperm of the grains shows a hybrid character, due presumably to the fusion of one of the pollen nuclei with the endosperm nucleus.[1]

[1] Webber. Xenia, or the Immediate Effect of Pollen in Maize. U. S. Department of Agriculture, Division of Vegetable Physiology and Pathology, *Bulletin No. 22*, 1900.

SUMMARY.

Peperomia, in regard to the embryo sac, probably represents the most primitive form yet described among the angiosperms. The absence of a definite egg apparatus and antipodals, and especially the increased number of nuclei, point to this. The single-celled archesporium of Peperomia is, however, probably less primitive than the multicellular sporogenous complex found in Casuarina and some other forms.

The similarity between the structure of the embryo sac in Peperomia (and perhaps Casuarina) and Gnetum is striking; but as the affinities of the latter are very doubtful, this does not throw much light upon the relationships existing between gymnosperms and angiosperms.

The typical embryo sac may very well have been derived from one like that of Peperomia, by the suppression of one nuclear division. The marked polarity, and the specialization of the egg apparatus and antipodal cells, are probably secondary characters, and the fusion of the polar nuclei has its prototype in the multiple fusion of the nuclei in Peperomia, to form the endosperm nucleus.

Peperomia offers a basis for an explanation of the homologies of the embryo sac. The egg cell probably represents an archegonium reduced to a single cell, and possibly the synergidæ may also represent potential archegonia, although it is quite as likely that they are derived from vegetative prothallial cells.

All of the other structures, the polar nuclei (and their product, the endosperm nucleus) and the antipodal cells, represent vegetative prothallial tissue. The increase in number met with in the antipodal cells of Sparganium, for instance, merely emphasizes their power to assume the rôle of active prothallial tissue.

The fusion of the polar nuclei is in no way to be considered as a true sexual process. The regular occurrence of a multiple fusion in Peperomia is a strong argument against such an assumption. It is much more probable that it is to be interpreted as a stimulus to further growth. The fusion of the second pollen nucleus with the endosperm nucleus must be considered as more or less accidental.[1]

[1] Strasburger. Einige Bemerkungen zur Frage nach der "doppelten Befruchtung" bei den Angiospermen, *Botanische Zeitschrift*, 1899.

THE VASCULAR SYSTEM OF THE COMMON SQUID, LOLIGO PEALII.

LEONARD W. WILLIAMS.

THE knowledge of the histology of the vascular system of the decapod mollusks is very incomplete. The nature and extent of the capillary system especially have been so little understood that two contrary opinions find expression in the text-books of zoölogy. It has been maintained by Lang that the arterial and venous systems are connected partly by capillaries and partly by lacunæ, which are portions of the primary body cavity, while Parker and Haswell affirm that the blood flows through a complete system of capillaries. I have been unable to find any published work which decides between these views. All agree that the vascular system is highly developed and that the capillary system is extensive, but no one seems to have investigated the structure of the vessels or to have determined the exact nature of the so-called lacunæ or sinuses. Prof. Ulric Dahlgren called my attention to this subject, and under his direction I worked upon the vascular system of the squid at Woods Hole during the summers of 1899 and 1900, and at Princeton University during the intervening time. The material, *Loligo pealii*, was furnished me by the Marine Biological Laboratory through the kindness of Professor Dahlgren, and by the United States Fish Commission through the kindness of Dr. H. C. Bumpus, and further material was obtained from the traps at Elberon, N. J.

The extent of the capillary system was determined by injecting the vessels with a saturated aqueous solution of Berlin blue. The injected tissues were studied while fresh and transparent or were fixed in acetic corrosive sublimate or 95 per cent alcohol and mounted in serial sections. The structure of the walls of the vessels was studied after impregnating them with silver in order to show the outlines of the endothelial or other

lining cells. Before injecting the solution of silver nitrate it was necessary to remove the chlorides from the vessels by irrigating them with a 5 per cent solution of potassium nitrate. This solution was followed by a ¼ per cent solution of silver nitrate, and after a few moments this was removed and the tissues fixed by the injection of 95 per cent alcohol. Small pieces of the several organs were dehydrated, cleared in creosote, and mounted. The contraction of the intrinsic muscles of the vessels renders complete injection very difficult, and to obviate this difficulty by dilating the vessels the injection fluids and the water in which the squid were kept were saturated with amyl nitrite. This method was not uniformly successful.

The general arrangement of the vascular system of the squid will be recalled by a glance at the diagram (Fig. 1) of

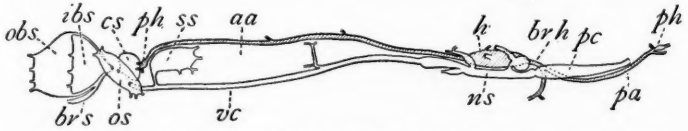

FIG. 1. — Diagram of the vascular system of the squid as seen from the left. *aa*, anterior aorta; *brh*, branchial heart; *brs*, brachial sinus; *cs*, cerebral sinus; *h*, heart; *ibs*, inner buccal sinus; *ns*, nephridial sinus; *obs*, outer buccal sinus; *os*, optic sinus; *pa*, posterior aorta; *pc*, postcava; *ph*, peripheral heart; *ss*, salivary sinus; *vc*, vena cava.

the system seen from the left. Arterial blood enters the one-chambered heart from the gills through the two branchial veins and is forced out through the anterior, posterior, and genital aortæ. The anterior aorta forks near the head, and each branch bears a muscular enlargement, called a peripheral heart, at the point where it breaks up into the branches which supply the head. The two branches of the posterior aorta which pass out of the mantle to the fins also have peripheral hearts. The latter are vascular sphincters, which probably contract synchronously with the mantle, and so prevent the transmission of an excessive blood pressure to the extra-pallial vessels. The blood returning from the arms through the brachial veins reaches the brachial sinus, which is connected with five sinuses, that partially enclose the pharynx, the eyes, and the brain. These sinuses open into the anterior vena cava, which also receives a vein from the sinus that encloses the salivary gland. The anterior

vena cava opens into the apex of the V-shaped nephridial sinus which is surrounded by the nephridial chamber. The venous blood from the dorsal end of the mantle returns through the two postcavæ which open into the ends of the arms of the nephridial sinus. This sinus opens at each side into a branchial heart which forces the blood through the gill to the systemic heart. The sinuses are not interposed between the veins and arteries but receive blood from the veins and return it to the veins. The aortæ, the larger arteries, the branchial arteries and veins, the anterior vena cava, and the postcavæ are all peristaltically contractile. The wave of contraction passes slowly away from the heart along the arteries, and toward the heart along the veins. The peristalsis of the vessels continues long after the stoppage of the hearts and the apparent death of the animal.

The Structure of the Arteries and Veins. — The systemic or arterial heart is composed of smooth muscle fibers. The external surface is firm, but the inner surface is formed by a latticework of interlaced fibers. The great irregularity of this surface interferes with the success of silver impregnations, and although some impregnations and microtome sections indicate that there is an endothelium, such a large number have yielded only negative results that it is probable that an endothelium is not present in the heart. The arterial blood which passes to the tissues of the heart from its lumen becomes venous and is carried to the nephridial sinus by two or three small veins. It is probable that these veins are separated from the lumen of the heart by capillaries. The vessels through which the blood passes are certainly as small as capillaries, but it was impossible to demonstrate an endothelium.

The branchial hearts are quite different from the systemic heart in that the muscle fibers are cross striated and are separated by numerous clusters of apparently glandular polygonal cells, which possibly have a function in connection with the pericardial gland that is attached to the inner edge of the heart and receives a large blood supply from it. Silver impregnation shows that an endothelium is not present and that the muscular and glandular cells are in contact with the blood.

A branch of the posterior aorta brings arterial blood to the tissues of the branchial heart.

The aortæ and the larger arteries are peristaltically contractile and thick walled. Their walls are formed by a thick sheet of peculiar muscular tissue, which is enclosed by two thin coats of connective tissue. The muscular tissue is formed of fusiform cells whose large oval nuclei have a small quantity of protoplasm at each end, but the greater portion of each cell consists of radiating fibers which interlace with those of neighboring cells. The muscle resembles connective tissue more than muscle, but it is actively contractile, for stimuli can be so applied that the peristaltic wave will move in the opposite direction to the blood current, and the peristalsis continues long after the final stoppage of the hearts.

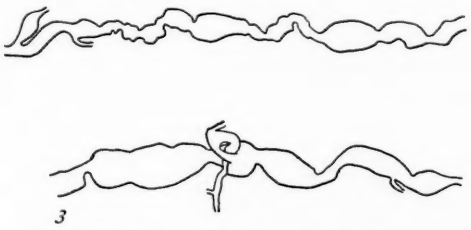

FIG. 2. — Arterioles which show the effect of the contraction of the scattered intrinsic muscle fibers of the vessels.

The muscular coat of the smaller arteries is much thinner, and the peculiar muscle cells are replaced by simple fibers, which are so irregularly distributed upon the smallest arteries that their contraction makes the vessels moniliform, as is shown in Fig. 2. Arterioles arising as lateral branches of an artery commonly have a strong band of muscle fibers at their origin.

The aortæ and their largest branches may have an endothelium, but the unavoidable contraction of their muscular walls throws the inner surface into longitudinal wrinkles, between which the silver is deposited in streaks that obscure the cell outlines. It is probable that an endothelium is present in these vessels; for, although almost all the evidence is negative, a few preparations seem to show the endothelium. The intermediate arteries are lined by an endothelium composed of

flat elongate cells that encircle the vessel. This endothelium gradually merges into the typical endothelium lining the smaller arteries. Bergh[1] found a similar arrangement in the arteries of the pulmonate gasteropods, except that he ascertained definitely that the larger arteries and the heart do not possess an endothelium but are lined by muscle fibers. He concludes that the endothelial cells are undifferentiated (*ungeformte*) muscle cells. There is nothing in the squid which tends to support such an explanation, for the larger vessels are almost certainly lined either by connective tissue or endothelium.

The veins have the same structure as the arteries except that their muscular coat is thinner or wanting and that all have a typical endothelium (Fig. 3). They may readily be distinguished from the arteries by their thinner walls. In many places an artery is accompanied by a pair of veins which anastomose frequently. Fig. 4 represents a portion of such an artery with its companion veins; the narrow initial caliber of the branches of the artery, due to the contraction of the intrinsic muscles of the vessels, should be noted.

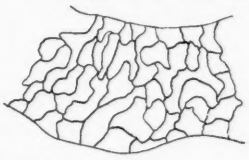

FIG. 3. — Endothelium of a vein. × 260.

The nephridial sinus passes through the nephridial cavity and is invested by the secretory nephridial epithelium. Both surfaces of the sinus wall are increased by interdigitating evaginations from the lumen of the vessel and from the nephridial cavity. The consequent irregularity of the surface of the walls causes many artifacts in silver preparations, so that the cell outlines cannot be followed certainly; nevertheless, sections indicate that an endothelium is present. The nephridial epithelium of the sinus is columnar and is supported by a membrane, the proper wall of the sinus, which carries the nutrient arteries of the wall.

The Capillaries. — The Berlin-blue injections which were intended to demonstrate the extent of the capillary system were perfectly successful. The injection fluid passed from the arteries through the tissues until it filled and flowed from

[1] Bergh, R. S. *Anat. Hefte*, I. Abth., Bd. x.

the veins, so that it is certain that the vascular system was fully injected. Serial sections of many portions of the squid, and gross mounts of portions of the skin, mesentery, and intestinal wall show conclusively that there is a perfect capillary network which connects the arteries and veins in all parts of the body. Like other capillaries, these (Fig. 4) branch and anastomose frequently without altering their diameter, and their walls are formed by an endothelium composed of flat oval cells with sinuous margins. The silver impregnations of the capillaries, though rarely successful, leave no doubt as to the nature of the wall.

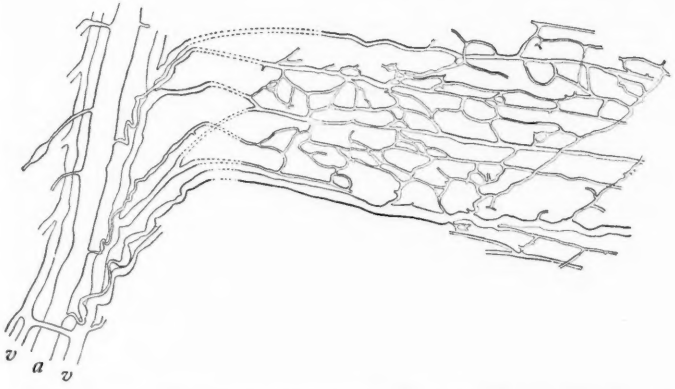

FIG. 4. — Artery, companion veins, and connecting capillaries sketched from the supporting membrane of the gill. *a*, artery; *v*, veins.

Some arterioles and capillaries are connected with lacuna-like cavities which may be called the end sinuses of the veins. Fig. 5 is a camera sketch of such a sinus situated in the visceral body wall. Similar sinuses have been found in the testis, glands, and muscles, and it is very probable that they are more widely distributed. Each sinus is a small irregular cavity, into which an arteriole passes and then breaks up into branches; the latter pass out of the sinus and communicate with the surrounding capillary plexus, some of whose branches open into the sinus, so that the blood must pass through the perforating arteriole and then through the capillaries into the

sinus.[1] The sinuses are connected with the veins by very small vessels. In partially successful injections the colored arteriole can be seen surrounded by a space filled with blood corpuscles, but in perfect injections both the arteriole and the sinus are filled with the injection mass. The arteriole, capillaries, and the sinus are all lined by endothelium. It was impossible to determine whether the endothelium of the sinus was reflected over the surface of the perforating arteriole. It is worthy of note that when the blood had not been driven out of the sinus the proportion of corpuscles in the blood of the sinus was six or eight times as great as in the other vessels, — a fact which

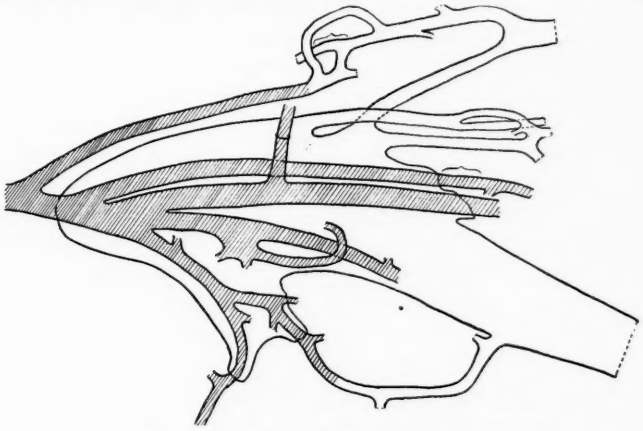

FIG. 5. — End sinus of vein, from visceral body wall.

may be due to the filtering out of the corpuscles as the blood was driven through the vessels by the injection fluids.

The Capillaries of the Gills. — The gills are not easily injected because a valve at the origin of the branchial artery prevents the free flow of injection fluids in either direction. The valve is formed by four tubercles which project in the direction of the blood current into the lumen of the artery. A band of muscle fibers forms a sphincter whose contraction forces the tubercles together so that the lumen of the vessel may be closed.

[1] The connection between these vessels and the veins has been inferred from the course of the injection fluids through the sinus.

Notwithstanding the resistance of this valve, successful capillary injections of Berlin blue were obtained as well as good silver impregnations of the veins and arteries. The capillaries are enclosed between epithelial plates which form the upper and lower surfaces of the gill and are separated from one another by small columns of cells which bind together the gill surfaces. The vascular endothelium could be traced only to the beginning of the capillaries, but microtome sections leave little doubt that the endothelium also extends into the capillaries.

The salivary sinus and the sinuses of the head (brachial, inner and outer buccal, optic, and cephalic), which are usually cited as examples of lacunæ, must be considered to be enormous dilations of the veins. They are so large that it is impracticable to examine every portion of their walls, but silver impregnations of portions of several sinuses show that they are lined by an endothelium. All the sinuses have essentially the same structure, so that the description of one sinus will convey a true conception of all. The outer buccal sinus surrounds the sides and dorsal surface of the oval pharynx as the pericardium invests the heart. The outer wall of the sinus is supported by the muscular ring at the base of the arms, and the inner wall is supported by the pharynx and by the muscular septum which separates the inner buccal sinus from the outer. The walls are formed by connective tissue and by the endothelium which it supports. Ten or fifteen small veins which arise in the peristomial membrane open into the ventral end of the sinus, and the brachial sinus opens into the dorsal end. The blood passes from the buccal sinus through the optic sinuses to the vena cava. Beside having definite walls, these sinuses, unlike lacunæ, do not connect arteries and veins, but receive blood from the veins and return it to the veins. The wide distribution of the capillary vessels, the presence of an endothelium around every blood-containing cavity, except possibly the hearts, and the absence of demonstrable lacunæ, all lead to the conclusion that the arterial and venous vessels of the squid are connected by capillaries so that the vascular system is closed.

BROWN UNIVERSITY.

WINDS AND STORMS AS AGENTS IN THE DIFFUSION OF INSECTS.[1]

F. M. WEBSTER.

By the term "winds" I wish to include even the mildest breezes as well as the strongest gales, the latter, either alone or in connection with thunderstorms, such as may and ordinarily do occur in our latitude during the warm months of the year. Throughout the northern states the keen, biting March winds find comparatively few insects abroad to be caught up, or who willingly surrender themselves to its power; and in late autumn, when the breeding season is nearly or quite over with the majority of species, they seem to prefer the quiet of the Indian summer to move about. In the one case, diffusion appears to be the one overwhelming object; while in the other, the object seems to be to reach particular locations or conditions that will best protect from the winter blasts which are to come later on in the year.

Whatever conduces to diffusion, must, as a rule, tend to increase fecundity — first by bringing the sexes together during the mating seasons, and second by enabling them to secure a greater food supply.

The effect of even very light breezes in enabling the sexes to meet at the proper time may be well illustrated by placing a female of some of our larger moths in a wire cage, and, hanging this in the open, noting the number of males that will soon be attracted and remain hovering about the cage, making every effort to reach the female within. The same may be observed in many Hymenoptera. It will be noted further that these males come to the cage against and not with the wind. With a continual absolute quiet, how much less liable would the sexes be to reach each other at the proper time for mating,

[1] Read before Section F, Zoölogy, American Association for the Advancement of Science, July 1, 1902.

especially such as are wingless among the females, or which, having wings, do not readily use them? If we trap insects by baits or by lights, we find that our catches will be largely of males or spent females, thus showing that, generally speaking, the male seeks the female. In the cases of some of our hymenopters and especially where males do not, or rarely, occur, and with others, like the Aphides, where the males only occur at a single definite time, this rule will not hold good, and our captures will be all of them females; and I think it is among such that will be found those that give themselves most freely to the embraces of the winds during the breeding seasons.

The influence of the winds in enabling insects to detect the location of their food is apparent in many ways. If we place the dead body of a bird, snake, or small animal under a bell glass in the fields, no carrion-loving insects will come to it; but if we substitute for the bell glass a wire cage, these will soon find their way to it, coming against and not with the wind. The two species of dung beetles, *Aphodius inquinatus* and *A. serval*, which appear, the one in the fall and the other in the spring, quickly find the fresh droppings of animals by aid of the wind. The plum curculio, *Conotrachelus nenuphar*, is said to approach a plum orchard more readily against the wind than with it, as has been determined by painting individuals and liberating them to the windward and leeward of a plum orchard just at the season for oviposition; and there is little doubt but that many of our wood-boring beetles are enabled to select a weakened tree by their acute sense of smell. Thus do the light winds enable many insects the better to find their food and each other, thereby greatly increasing their numbers in any given place.

The high winds and gales, unaccompanied by rain, thunder, and lightning, also exert a powerful influence in the diffusion of insects. But before taking up the direct subject of influences of high winds exclusively, it may be well to call attention to some of the effects of prevailing winds, that is, winds both light and heavy but which come most continuously from one direction during the period when insect diffusion is most susceptible to their influences. A most convincing illustration in

this direction is offered by the spread of the San José scale in orchards, especially in the Middle West. If infested trees, brought from the nursery and transplanted to the orchard, happen to be set along the north or east margins of an orchard, the spread through that orchard is comparatively slow; but on the other hand, if the infested trees happen to be placed along the west or south margins, the progress is much more rapid. So also, where the introduction is into a section of country largely devoted to tree fruits, the spread over the country is much more rapid towards the northeast than in any other direction. This is for the reason that our prevailing winds, during the period when the young are carried from one place to another by these winds, blow from the southwest or west, more generally the former. In the case of the Hessian fly, *Cecidomyia destructor*, I have noted that, where a field of wheat has been seriously attacked in the fall, and adjoining fields have escaped, some of these last may be seriously attacked the following spring, while others seemingly equally exposed to attack almost entirely escape injury. A careful examination into the facts, however, will show that this is due to the direction of the prevailing winds at the time when the spring brood of flies were abroad, and the wind simply carried them toward those fields that were located in one direction and away from those located in the opposite direction, thereby to a certain extent protecting the one from attack and causing the destruction of the other. In the case of the San José scale, active only in the very young larva, I have noted that, where infested trees happen to be placed in a gully extending up a steep hill, the spread will be much more rapid upward than downward, as the air current is in that direction. So, then, prevailing winds have in some cases much to do with the spread of insects in certain directions. The influence of high winds on insects is illustrated in one way by the great number of butterflies that are sometimes encountered by ships at sea, long distances from land. Indeed, the entomological fauna of very many of the islands of the sea indicates very strongly that insects have become established on such islands by having been blown from the mainland, or from other islands located at considerable

distances away.[1] Dr. Henry C. McCook, in his great work on *American Spiders and their Spinning Work*, has shown how the huntsman spider, *Heteropoda venatorius*, on account of its aeronautic habits, might well have circumnavigated the globe with the aid of the trade winds, basing his calculations on the localities where the spider is known to occur and the direction of these winds. The late Dr. D. S. Kellicott told me of the sudden appearance of considerable numbers of the cotton-worm moth, *Aletia argillacea*, at Columbus, Ohio, immediately following a gale from the southwest; and, besides, we know that this moth has been found as far north as western Ontario, with no evidence of its having developed there in a single instance. Years ago, while studying the habits of the buffalo gnat, in the Southern States, one of the most perplexing questions that confronted the planter, relative to the habits of this bloodthirsty insect, was their sudden appearance in a locality in such immense swarms as to kill thousands of head of cattle, mules, and other domestic animals, before these could be gotten to a place of safety. Early in my investigations, I found that the adult gnats emerged from the waters of the bayous and clustered upon the surrounding vegetation in such numbers as to fairly cover the same, and a sudden high wind would carry these gnats along with it and distribute them for miles over the cotton plantations, there to carry on their bloody work. Thus, these insects might appear suddenly in immense numbers, ten or twelve miles from their place of breeding, in one direction, while in the direction opposite they might not occur

[1] Since the preparation of this paper the following note has come to me:

The 'Blue Page' Moth. — During the gale that reached Barbados and St. Vincent on August 26, 1901, numbers of a large moth were found in Barbados, of a kind not known to breed there. They had evidently been brought by the high southwest wind. Some were caught and identified as *Urania sloanei*, the 'blue page' of Trinidad, and they had apparently come from the mainland or, more probably, from Trinidad itself. They were found as far north as Dominica, and one was caught on the R. M. S. 'Eden' midway between St. Lucia and Barbados. This is an excellent instance of how insects spread from island to island, and had these moths found suitable conditions in Barbados, they might have become established there and formed an addition to the permanent fauna. The direct distance from Trinidad to Barbados is about 160 miles, and to Dominica is some 100 miles more. — *The* (Barbados) *Agricultural News*, June 7, 1902.

at all, — the direction depending on that of the wind ; and a wind prevailing from the same direction during the breeding season one year would affect a certain territory, while the following year the prevailing winds might be from another quarter, and so cause these insects to terrorize an entirely different section of country. Formerly, and before the advent of the electric motor as a means of propelling street cars, when these gnats developed, during some seasons, in the St. Francis bottoms, across the Mississippi River west of Memphis, Tenn., these insects might occur in their breeding grounds in immense swarms, but so long as the prevailing winds were from an easterly direction few of them would be observed in Memphis ; but let a strong gale set in suddenly from the west and these bloodthirsty insects would suddenly appear in such numbers as to prevent the running of the street cars, which were then drawn by mules ; these last would be killed in their harnesses, and the cars were necessarily abandoned until these gnats disappeared. Of course the introduction of electricity, and the disappearance of the mules as a means of motive power has, in this case, overcome the difficulty, but former conditions offered a good illustration of the far-reaching influences of the wind on some insects. It may be mentioned that the gnats that were so driven about by the wind were all sterile females and the species was not, in this particular case, permanently diffused by this means. Somewhat similar effects of winds are to be observed as affecting the various species of migratory locusts, the exact territory devastated by them often being dependent on the direction of the prevailing winds during the migrating season.

Relative to the concluding point in this paper, *viz.*, the influence of wind and thunderstorms combined on insect diffusion, I beg to call attention to a most interesting series of papers contributed to *Prometheus*, a German scientific journal much like our *Scientific American*, by Prof. Karl Sajö, of Budapest, Hungary. Professor Sajö says that it is known that "before thunderstorms the crayfish come out of the water into the grass on the banks of the river or lake ; many fishes act as if they were insane, and many birds and mammalia become

irritated and angry. Even the micro-organisms are subject to similar changes; for instance, before thunderstorms in late fall, the wine fermentation can reach so great a violence as to cause the fermenting juice to suddenly run out of the vats. The greater the change in the atmosphere, the greater the unrest of the living being." If one happens to be at a farmhouse in our own country, where ice is not freely used, and a thunderstorm occurs, any farmer's wife will complain that the thunder and lightning have soured the milk. Continuing, Professor Sajö calls particular attention to the "great unrest and activity that takes place in the insect world just in the sultry hours preceding a thunderstorm, and to the fact that insects in the air at the time the storm bursts are driven like chaff to great distances, — perhaps into other countries, across rivers, lakes, and mountains; not only the species that fly but many that do not fly may thus be transported to new homes." And again, "Many Aphides creep to the crowns of the plants, then drop themselves at the proper moment into the violent current of the storm. A number of these insects land in places where there is no food supply for them and they die. A part of them reach places where their species is already established, and fare no better. Part are thrown into the water, sometimes in oceans, and perish. A proportionally small number arrive at such places as may be called really favorable for their diffusion, *viz.*, where the species has never established itself before, or, having done so, died out before the arrival of newcomers, and, therefore, natural enemies had not preceded them. Such individuals as are thus thrown into favorable places have a chance to multiply into large, populous colonies within a short space of time, and continue until their enemies find them out, or they become over-populous and devour all of their food supply, resulting in what to them is famine."

There is probably not an American entomologist who has not encountered illustrations similar to those enumerated by the writer of the above, and, while we may not have wholesale introductions of new things among us, there is no doubt that localities are often first colonized by certain kinds of insects in this manner, whereas the wind or the

thunderstorm acting separately would not bring about such a condition of affairs.

I have stated that, in applying trap lights or lanterns, or edible baits like sweetened sour beer, we, as a rule, secure males and spent females, but the influence of weather conditions that usually precede a thunderstorm (that is, a close, sultry condition) has the effect of bringing out both sexes, — a result due, so far as can now be determined, to some subtile action on their sexual life. As Professor Sajö so aptly illustrates this point, I will quote him again quite fully. "What influence the weather has, especially on the activity of sexual life, must be known to every zoölogist; even man is not an exception from these 'living barometers.' Not only children, not only the female sex, but the sick ones experience the influence of the weather on the functions, especially on the nervous system; and everybody without exception are thus influenced, though not all may be aware of the fact. The same causes that in many produce unrest and irritation render others dizzy, stupid, or sleepy, according to the temperament of the individual." The effect of electricity on the nervous systems of insects, especially as relative to their love affairs, would constitute an interesting study, and one that ought to be carried out; but even as it is, we can see that the thunderstorm, in conjunction with the wind, may accomplish in the diffusion of insects that which neither element alone would bring about.

THE COLORS OF FISHES.

DAVID STARR JORDAN.

Pigmentation.—The colors of fishes are in general produced by oil sacs or pigment cells beneath the epidermis or in some cases beneath the scales. Certain metallic shades, silvery blue or iridescent, are produced, not by actual pigment, but, as among insects, by the deflection of light from the polished skin or the striated surfaces of the scales. Certain fine striations give an iridescent appearance through the interference of light.

The pigmentary colors may be divided into two general classes, ground coloration, and ornamentation or markings. Of these the ground color is most subject to individual or local variation, although usually within narrow limits, while the markings are more subject to change with age or sex. On the other hand, they are more distinctive of the species itself.

Protective Coloration.—The ground coloration most usual among fishes is protective in its nature. In a majority of fishes the back is olivaceous or gray, either plain or mottled, and the belly white. To birds looking down into the water, the back is colored like the water itself or like the bottom below it. To fishes in search of prey from below, the belly is colored like the surface of the water or the atmosphere above it.

In shallow waters or in rivers the bottom is not uniformly colored. The fish, especially if it be one which swims close to the bottom, is better protected if the olivaceous surface is marked by darker cross streaks and blotches. These give the fish a closer resemblance to the weeds about it or to the sand and stones on which it lies. As a rule, no fish which lies on the bottom is ever uniformly colored.

In the open seas, where the water seems very blue, blue colors, and especially metallic shades, take the place of olivaceous gray or green. As we descend into deep water, especially

in the warm seas, red pigment takes the place of olive. At a depth of 50 to 150 fathoms in the tropics a large percentage of the fishes are of various shades of red. Several of the large groupers of the West Indies are represented by two color forms, a shore form in which the prevailing shade is olive green, and a deeper water form which is crimson. In one case an intermediate color form also exists, which is lemon yellow. On the coast of California is a band-shaped blenny which appears in three colors, according to its surroundings, blood red, grass green, and olive yellow. The red coloration is also essentially protective, for the region inhabited by such forms is the zone of the rose-red algæ. In the arctic waters, and in lakes where rose-red algæ are not found, the red ground coloration is almost unknown, although red may appear in markings or in nuptial colors. It is possible that the red, both of fishes and algæ, in deeper water is related to the effect of water on the waves of light, but whether this should make fishes red or violet has never been clearly understood. It is true, also, that where the red in fishes ceases violet black begins.

In the great depths, from 500 to 4000 fathoms, the ground color in all fishes becomes deep black or violet black. This shade is also protective. In these depths the sun's rays scarcely penetrate, and the fish and the water are of the same apparent shade, for black coloration is here the mere absence of light.

In general, the markings of various sorts grow less distinct with the increase of depth. Bright red fishes of the depths are usually uniform red. The violet-black fishes of the oceanic abysses show no markings whatever (luminous gland excepted), and in deep waters there are no nuptial or sexual differences in color.

Ground colors other than olive green, gray, brown, or silvery rarely appear among fresh-water fishes. Marine fishes in the tropics sometimes show as ground color bright blue, grass green, orange yellow, or black; but these showy colors are almost confined to fishes of the coral reefs, where they are often associated with elaborate systems of markings.

Protective Markings. — The markings of fishes are of almost every conceivable character. They may be roughly grouped as protective coloration, sexual coloration, nuptial coloration, recognition colors, and ornamentation, if we may use that term for brilliant hues which serve no obvious purpose to the fish itself.

Examples of protective markings may be seen everywhere. The flounder which lies on the sand has its upper surface covered with sandlike blotches, and these again will vary according to the kind of sand it imitates. It may be true sand or crushed coral or the detritus of lava, in any case perfectly imitated.

Equally closely will the markings on a fish correspond with rock surroundings. With granite rocks we find an elaborate series of granitic markings, with coral rocks another series of shades, and if red corals be present, red shades of like appearance are found on the fish. Still another kind of marks indicates rock pools lined with the red calcareous algæ called Corallina. Black species are found in lava masses, grass-green ones among the fronds of ulva, and olive-green among Sargassum or fucus, the markings and often the form corresponding to the nature of the algæ in which the species makes its home.

Sexual Coloration. — In many groups of fishes the sexes are differently colored. In some cases bright red, blue, or black markings characterize the male, the female having similar marks, but less distinct, and the bright colors replaced by olive, brown, or gray. In a few cases, however, the female has marks of a totally different nature, and scarcely less bright than those of the male.

Nuptial Coloration. — Nuptial colors are those which appear on the male in the breeding season only, the pigment afterwards vanishing, leaving the sexes essentially alike. Such colors are found on most of the minnows and dace (Cyprinidæ) of the rivers and to a less degree in some other fresh-water fishes, as the darters (Etheostominæ) and the trout. In the minnows of many species the male in spring has the skin charged with bright pigment, red, black, or bright silvery, for the most part, the black most often on the head, the red on the head and body, and the silvery on the tips of the fins.

At the same time other markings are intensified, and in many species the head and sometimes the body and fins are covered with warty excrescences. These shades are most distinct on the most vigorous males, and disappear with the warty excrescences after the fertilization of the eggs.

Nuptial colors do not appear among marine fishes, and in but few families are the sexes distinguishable by differences in coloration.

Recognition Marks. — Under the head of "recognition marks" may be grouped a great variety of special markings, which may be conceived to aid the representatives of a given species to recognize each other. That they actually serve this purpose is a matter of theory, but the theory is plausible, and these markings have much in common with the white tail feathers, scarlet crests, colored wing patches, and other markings regarded as recognition marks among birds.

Among these are ocelli, black or blue ringed with white or yellow, on various parts of the body; black spots on the dorsal fin; black spots below or behind the eye; black, red, blue, or yellow spots variously placed; crossbars of red or black or green, with or without pale edges; a blood-red fin among pale ones or a fin of shining blue; a white edge to the tail; a yellow, blue, or red streamer to the dorsal fin, a black tip to the pectoral or ventral; a hidden spot of emerald in the mouth or in the axil; an almost endless variety of sharply defined markings, not directly protective, which serve as recognition marks, if not to the fish itself, certainly to the naturalist who studies it.

These marks shade off into an equally great variety for which we can devise no better name than "ornamentation." Some fishes are simply covered with brilliant spots or bars or reticulations, their nature and variety baffling description, while no useful purpose seems to be served by them, unless we stretch still more widely the convenient theory of recognition marks.

In many cases the markings change with age, certain bands, stripes, or ocelli being characteristic of the young and gradually disappearing. In such cases the same marks will be found permanent in some related species of less differentiated coloration. In such cases it is safe to regard them as ancestral.

In case of markings on the fins and of elaborate ornamentation in general, it is best defined in the oldest and most vigorous individuals, becoming intensified by degrees.

Intensity of Coloration. — In general, coloration is most intense and varied in certain families of the tropical shores, and especially about coral reefs. But in brilliancy of individual markings some fresh-water fishes are scarcely less notable, especially the darters (Etheostominæ) and sunfishes (Centrarchidæ) of the streams of eastern North America. The bright hues of these fresh-water fishes are, however, more or less concealed in the water by the olivaceous markings and dark blotches of the upper parts.

Coral Reef Fishes. — The brilliantly colored fishes of the tropics seem to scorn the need of protective coloration. They save themselves from their enemies in most cases by excessive alertness and activity (Chætodon, Pomacentrus), or else by burying themselves in coral sand (*Jules gaimardi*), a habit more frequent than has been suspected.

Fading of Pigments in Spirits. — In the preservation of specimens most red and blue pigments fade to whitish, and it requires considerable care to interpret the traces which may be left of red bands or blue markings. Yet some blue pigments are absolutely permanent, and occasionally blood-red pigments persist through all conditions. Black pigment seldom changes in spirits, and olivaceous markings simply fade a little without material alteration. It is an important part of the work of the systematic ichthyologist to learn to interpret the traces of the faded pigment left on specimens he may have occasion to examine. In such cases it is more important to trace the markings than to restore the ground color, as the ground color is at once more variable with individuals and more constant in large groups. In other words, it varies a good deal, but in almost constantly narrow limits.

Variation in Pattern. — Occasionally, however, a species is found in which, other characters being constant, both ground color and markings are subject to a remarkable range of variation. In such cases the actual unity of the species is open to serious question. The most remarkable case of such variation

known is found in a West Indian fish, the vaca, which bears the incongruous name of *Hypoplectrus unicolor*. In the typical vaca the body is orange with black marks and blue lines, the fins checkered with orange and blue. In a second form the body is violet, barred with black, the head with blue spots and bands. In another form the blue on the head is wanting. In still another the body is yellow and black, with blue on the head only. In others the fins are plain orange, without checks, and the body yellow, with or without blue stripes and spots, and sometimes with spots of black or violet. In still others the body may be pink or brown, or violet black, the fins all yellow, part black or all black. Finally, there are forms deep indigo blue in color everywhere, with cross bands of indigo black, and these again may have bars of deeper blue on the head or may lack these altogether. I find no difference among these fishes except in color, and no way of accounting for the differences in this regard.

A species of puffer (*Tetradon setosus*) shows similar remarkable variations, being dark gray with white spots, but varying to indigo blue, lemon yellow, or sometimes having coarse blotches of either. Lemon-yellow varieties of several species are known, and these may be due to a failure of pigment, a sort of semi-albinism. True albinos, individuals wholly without pigment, are rare among fishes.

FLOWERS AND INSECTS IN NEW MEXICO.

T. D. A. COCKERELL.

In a certain sense we may say correctly that the flora of our country is fairly well known. New species, and even genera, are frequently described, but most of these are segregates from the more comprehensive groups of earlier authors, and radically new types are not often met with. Nevertheless, there is hardly a plant upon which new observations may not be made with ease. Our whole flora needs redescribing from living plants, every species needs close study to determine the character and range of its variations, and the relations between plants and insects offer a field for research which appears practically inexhaustible. The following notes record the results of some recent researches, and may serve as a contribution to entomophytology. They are classified according to locality.

Rio Ruidoso, White Mountains.

This is an alpine region in southern New Mexico, possessing a remarkably interesting flora, with quite a number of apparently endemic types. Prof. C. H. T. Townsend collected there a large number of bees, together with the flowers on which they were found. Some of these have been recorded, but the following data are new:

(1) *Verbena macdougalii* Heller. A very common species in New Mexico, formerly regarded as *V. stricta*, but separated by Heller on what seem to be perfectly valid grounds. The lilac-purple flowers are arranged in long spikes, so that the plant looks entirely different from the ordinary kinds of Verbena, which are adapted to butterflies. At the foot of Baldy Mountain, near Elizabethtown, Mrs. O. St. John found a variation (mut. nov. *rosella*) with pink flowers. The ordinary form was growing at the same place, which had an altitude of about 9600 feet.

Although our common types of Verbena (*V. macdougalii*, *V. bipinnatifida*, and *V. bracteosa*) look so entirely different, they all have the throat of the corolla covered with the same peculiar moniliform hairs.

V. macdougalii is an excellent bee plant. On the Rio Ruidoso, Townsend collected from the flowers the following bees: *Anthophora cleomis* Ckll. ♀, *A. montana* Cress. ♀, *Clisodon terminalis* Cress., *Anthidium maculosum* Cress., *Anthophora californica* Cress. ♂, *Megachile fortis* Cress., *Melissodes ruidosensis* Ckll., *Synhalonia crenulaticornis* Ckll. ♂, *Calliopsis rhodophilus* Ckll. ♀. It will be noted that these are long-tongued bees.

(2) *Monarda stricta* Wooton. Another very common New Mexico plant, only lately recognized as a distinct species. Its conspicuous heads of pink flowers are attractive to certain long-tongued bees, of which Townsend collected *Anthophora cardui* Ckll. ♂, *A. cleomis* Ckll. ♂, *Clisodon terminalis* Cress., and *Megachile fortis* Cress. The flowers are also visited by Bombus, as I have recorded elsewhere (*Annals and Magazine Natural History*, November, 1899), and Townsend took a single male *Melissodes montana* Cress. He also took a butterfly, *Epargyreus tityrus* Fabr., not hitherto recorded from New Mexico. These results accord fairly well with those of Loew, who observed the insect visitors of Monarda in the Botanic Garden at Berlin.

	Bombus.	Other long-tongued bees.	Short-tongued bees.	Butterflies.
M. stricta, New Mexico	9	5	0	1
M. spp., Berlin	2	2	1	2

Both lists are doubtless very incomplete.

(3) *Rhus glabra* L. A widely distributed shrub, with conspicuous panicles of greenish flowers. The visitors might be expected to be much like those of the Umbelliferæ, but Townsend actually obtained a number of bees: *Bombus sonorus* Say, *B. prunellæ* Ckll., *Colletes gilensis* Ckll. ♂, *Coelioxys gilensis* Ckll., *Heriades gracilior* Ckll., *Colletes americana* Cress. ♂. He also obtained a butterfly, *Basilarchia weidemeyerii* Edw. In Europe Müller found the honeybee abundant on the allied *Rhus hirta*. In Illinois Robertson found fifty-eight species of insects on *R. glabra*, of which nineteen were bees, mostly short-tongued.

(4) *Potentilla thurberi* Gray. This is a beautiful species, differing from the ordinary species of the genus by its dark crimson flowers, on which Townsend took the following: *Megachile fortis* Cr., *Colletes gilensis* Ckll. ♂, *Vespa occidentalis* Cr.

(5) *Geranium atropurpureum* Heller. A common New Mexico plant, only recently recognized as distinct. Visited by males of *Colletes gilensis* Ckll., a short-tongued bee.

(6) *Heliopsis scabra* Dunal. Visited by *Megachile fortis* Cr., *Anthidium perpictum* Ckll., *Megachile fidelis* Cr., — all long-tongued bees. From *H. helianthoides*, in Illinois, Robertson collected twenty-two bees, fourteen being long-tongued.

A few other miscellaneous observations are to be recorded: *Anthophora cleomis*, ♂, at *Prunella vulgaris*, and ♀ at *Verbascum thapsus*; *Clisodon terminalis* at *Prunella vulgaris* and *Verbascum thapsus*; *Halictus angustior* at *Erysimum asperum*; *Melissodes ruidosensis* at *Erigeron macranthus*; *Vespa diabolica* at *Solidago trinervata* and *Sicyos parviflorus*; *Andrena barberi* at *Solidago trinervata*.

La Cueva, Organ Mountains.

This locality, also in southern New Mexico, is at the eastern side of the Mesilla valley, and has an altitude of about 5000 feet. The records given below are based on collections by Prof. C. H. T. Townsend:

(1) *Datura meteloides* DC. A magnificent species, with large, heavily scented white flowers. Although no doubt properly a sphinx-moth flower, it was visited by the following bees: *Xylocopa arizonensis* Cr., *Caupolicana yarrowi* Cr., *Anthophora montana* Cr., *Agapostemon viridulus* Fabr. (new to New Mexico), *Augochlora neglectula* Ckll. The Caupolicana flies early in the morning, before sunrise. According to Mr. Friese (*in litt.*) the Chilian *C. curvipes* Friese (♂) agrees with *C. yarrowi*.

(2) *Lippia wrightii* Gray (Verbenaceæ). A shrubby plant, characteristic of the region. Visited by *Xylocopa arizonensis* Cr., *Caupolicana yarrowi* Cr., *Anthophora montana* Cr., *Perdita albovittata* Ckll. (1 ♀), *Augochlora neglectula* Ckll., *Synhalonia crenulaticornis* Ckll. var. ♂ (clypeus yellow except the hind border broadly), — all bees, five long-tongued.

(3) *Tourerea multiflora* (Nutt.) Visited by bees: *Perdita mentzeliarum* Ckll. and *Anthophora californica* Cr. I learn from Dr. Rydberg that Tourerea, Eaton and Wright, takes the place of Hesperaster; the combination here given will be credited to him.

(4) *Phacelia congesta* Hooker. Visited by bees: *Ceratina nanula* Ckll. (3 ♀, 1 ♂), *Halictus ruidosensis* Ckll. (1 ♀), *Perdita phaceliæ* Ckll. These are all small bees.

Other observations are: *Nomada gutierreziæ* Ckll., on *Verbesina encelioides; Nomia foxi* D.T. and *Exomalopsis solani* Ckll., on *Solanum elæagnifolium; Augochlora neglectula* Ckll., at *Parthenium incanum.*

ROMEROVILLE.

A locality about six miles from Las Vegas. In *Entomological News*, 1901, p. 40, five insects are recorded from Ribes, *sp.* at this place. It can now be stated that the Ribes is *R. leptanthum veganum* Ckll. (*Proceedings of the Biological Society of Washington*, 1902, p. 99).

LAS VEGAS.

(1) *Asclepias verticillata* L. This is very attractive to flies; the following were taken from its flowers: *Syritta pipiens* L. (July 3, N. Stern), *Eristalis latifrons* Loew (July 3, M. Winters), *Echinomyia algens* Wied. (July 21), *Peleteria tessellata* Fab. (July 21), *Myiophasia ænea* Wied. (July 21). *Lygæus reclivatus* Say is also common on the plant. Robertson collected 115 species of insects from this plant in Illinois.

(2) *Ribes longiflorum* Nutt. The yellow-flowered currant, common both wild and cultivated in the vicinity. On May 12 Loyola Dillon and Olive Barnes collected on the flowers four species of bees and one wasp: *Bombus nevadensis aztecus* Ckll. ♀, *Halictus coriaceus* Smith ♀, *H. armaticeps* Cr. ♀, *H. pruinosus* Rob. ♀, Odynerus, *sp.* On May 9 of last year a ♀ *Synhalonia frater*, Cr. var. (new to New Mexico), was taken at the flowers. This and the Bombus can probably get some nectar, but the Halicti only get pollen.

(3) *Anogra albicaulis* is a large white evening primrose, doubtless intended for moths, but on May 29 Eldon Tuttle and Leo Tipton discovered a minute new bee of the genus Perdita visiting its flowers at Las Vegas.

Perdita anogræ, n. sp., ♂. Length about 3½ mm.; head and thorax very dark olive green; cheeks unarmed; face below antennæ all bright yellow except the clypeal dots, yellow not extending upwards in middle line, but at sides going a little above the antennæ and then terminating abruptly, just touching the facial foveæ, making slightly more than a right angle with the eye; eyes pale green, the lower half of the posterior orbital margin narrowly bordered with yellow; face and mesothorax not conspicuously hairy; antennæ pale orange, dark brown above as far as third joint of flagellum; vertex and mesothorax minutely sculptured, but rather shining; tubercles light yellow; pleura

all dark; tegulæ pale brownish, with a yellowish spot; wings rather small, hyaline, brilliantly iridescent; nervures and stigma sepia brown, third discoidal distinct; marginal cell obliquely truncate; second submarginal narrowed to a point above; legs brownish-orange, the femora black behind, tibiæ with a dark brown stripe on outer side, tarsi with at least the last joint darkened; abdomen rather broad, shining black, with transverse wedge-shaped bluish-white marks on the sides of segments two to four; ventral surface black.

In my table in *Bulletin of Laboratory of Denison University*, XI, this runs to section 30, where it is at once distinguished by its spotted abdomen. It is closely allied to *P. sexmaculata*, agreeing in the ornamentation of the face and color of the antennæ, but the color of the abdominal spots is entirely different, as also is the shape of the second submarginal cell, and *P. anogræ* is a smaller insect than *sexmaculata*.

(4) *Verbena bipinnatifida* Nutt. is a plant with umbel-like heads of brilliant purple flowers, allied to the Verbena of gardens, and adapted to butterflies. On June 7 I saw it visited by the butterfly *Pyrameis cardui* and the day-flying hawk moth *Deilephila lineata;* but to my surprise I also saw a female *Anthophora montana*, a long-tongued bee, sucking vigorously and apparently successfully. She had not collected any pollen.

(5) *Phlox nana* Nutt. A small species characteristic of our region, with brilliant pink flowers. It is adapted to butterflies, but on June 7 I saw a short-tongued bee, *Agapostemon texanus*, ♀, repeatedly trying to suck and of course getting nothing. Elias Nelson, in his revision of Phlox, says the corolla of *P. nana* is "red" or "white." It is always whitish beneath, but the upper surface is typically bright pink, varying, however, at Las Vegas to pale mauve (forma *lilacina*) and white with a large pink "eye" (forma *oculata*), the markings round the throat remaining the same in each case.

(6) *Sophora sericea* Nutt. is a plant allied to Astragalus, with conspicuous white flowers. It seems to be adapted to bumblebees, and is visited by *Bombus morrisoni*.

Engle.

Engle is a locality near the Rio Grande about fifty miles north of Las Cruces. Nothing has hitherto been known of its insect fauna.

Astragalus bigelovii Gray. One of the so-called "loco-weeds" common in the southern part of New Mexico in open ground. The leaves are densely covered with white silky hairs.

Miss Nora Newberry, during the latter part of April and the first few days of May, collected from the flowers a number of long-tongued bees, which prove to be as follows :

(1) *Synhalonia lycii* Ckll., both sexes ; the male was not before known. In the male the clypeus, labrum, and a small, broadly triangular supraclypeal area are cream-color. (In the males of *S. edwardsii* and *frater* the clypeus is very bright yellow, and there is no supraclypeal mark.)

(2) *Anthophora affabilis* Cr. ♀. The identity of this has been confirmed by Mr. Fox, who compared it with Cresson's type. In the Mesilla valley it visits *Lycium torreyi*.

(3) *Anthophora porteræ* Ckll. Several females; only two specimens of this species were previously known. It is readily distinguished from *A. affabilis* by the black hair mixed with the light on the mesothorax. The female nearly agrees with the description of *A. ignava* Cr., but Mr. Fox has kindly compared it with Cresson's type, and assures me that it is different. Mr. Fox remarks that the female seems to agree with *A. edwardsii* Cr., except that it is larger; the male, however, has not the tooth on inner side of hind joint of posterior tarsi, and the lateral face-marks are not "lanceolate," but are shaped like a rose-thorn. A male *A. porteræ* was taken at flowers of *Ribes longiflorum*, at Las Vegas, N.M., May 15, 1902, by Eldon Tuttle and Leo Tipton. It differs from the original type in having more yellow on the scape and rather more black hair on the mesothorax. A character overlooked in the original description is a little pencil of black hair overlapping the upper anterior corner of each eye.

It is to be noted that both Synhalonia and Anthophora visit Ribes, Lycium, and Astragalus, plants of very different affinities but similar in their adaptation to long-tongued bees

TROUT SPRING.

This is a locality in Gallinas Cañon, N.M., some miles above Las Vegas Hot Springs. It is of interest on account of the mixed boreal and austral elements in its fauna and flora, the result in large measure, no doubt, of the narrowness of the cañon, whereby some slopes get little or no sun, while others are well warmed. The abundance of *Pinus scopulorum* and *Populus angustifolia* indicate the Transition Zone, while *Heracleum lanatum*, *Dasiphora fruticosa*, and *Ribes irriguum* are

distinctly Canadian Zone types. A fine bush of the last mentioned grew on the north side of a huge rock, shaded from the sun. An Upper Austral representative is *Ribes longiflorum* (a variety, however, with the petals deep red, the calyx tube often reddish outside, the flowers about 14 mm. long, and the apex of the leaves obtuse, thus closely approaching the northern *R. aureum*, as restricted by Coville), while at its flowers we found the typically southern butterfly *Epargyreus tityrus* Fabr., which extends to South America and the West Indies. The bright yellow flowers of the Canadian Zone Thermopsis were visited by a female *Megachile wootoni* Ckll., a bee of a strictly alpine and boreal type. A magpie (*Pica pica hudsonica*) was also to be regarded as a boreal representative. The pink flowers of the Upper Austral and Transition *Phlox nana* were seen in the cañon a short distance below Trout Spring.[1]

The insect visitors of one species of plant were rather carefully studied by my wife and myself, May 24, 1902.

Iris missouriensis Nutt. Visited by bees, butterflies, and flies. The bees crawl in under the petaloid divisions of the style, and so doubtless effect cross fertilization. The butterflies and flies (Bombyliidæ) suck from between the perianth segments, and appear to get their meal without paying for it.

The following insects were observed:

(1) *Colias eurytheme* ♀, Lycæna, Thanaos, — all butterflies, sucking.

(2) *Bombylius major* L., with proboscis 8–8½ mm. long, very abundant, sucking. In Europe a syrphid (Rhingia) with a proboscis 11 mm. long visits *Iris pseudacorus*, as is described by Müller.

The remaining species are bees:

(3) *Megachile wootoni* Ckll., *Megachile latimanus* Say. A male of each found sitting on the flowers, perhaps waiting for the females.

(4) *Synhalonia frater* Cresson. One of each sex.

(5) *Anthophora bomboides neomexicana* Ckll. One ♂.

(6) *Halictus coriaceus* Smith. One ♀.

[1] Mr. Eldon Tuttle lately found in Las Vegas a flower of *Phlox nana* with the limb 8-parted, a character which, if not aberrational, would take it out of the Polemoniaceæ. I have since found a flower with the limb 7-parted.

(7) *Augochlora confusa* Rob. Two ♀. These differ from a specimen received from Mr. Robertson in having the basal area of metathorax bounded by a sharp rim, but Robertson's description indicates that such specimens occur also in Illinois. The species is new to New Mexico.

(8) *Osmia pusilla* Cresson, one ♂; Osmia, two new species, males. I have sent these to Mr. Titus, who is revising the genus.

LAS VEGAS HOT SPRINGS.

Verbena macdougalii was visited July 11 by bombyliid flies, *Systoechus vulgaris* Lw. (det. Coq.), as observed by Miss M. Holzman.

Ribes cereum Dougl. was visited May 24 by *Bombus juxtus* Cresson.

I will take this opportunity to record from Las Vegas Hot Springs the dragon fly *Hyponeura lugens* Hagen. Prof. J. A. Needham, who kindly identified it, states that the genus is new to the United States, but there are specimens from Arizona in the Cornell University collection, not hitherto recorded.

APPENDIX.

Two New Species of Osmia.

The two new species of Osmia collected on flowers of Iris at Trout Spring, N.M., were sent to Mr. Titus with the expectation that they might prove identical with species which he had already described in MS. As this is not the case, they are briefly diagnosed below. Some additional notes and comments will be given by Mr. Titus when he publishes his revision of the American species of Osmia.

Osmia iridis Cockerell and Titus, *n. sp.*

♂. Length 9 mm., stout; head and thorax yellowish-green; abdomen dark blue-green; antennæ long, slender, entirely black, subtruncate at apex; pubescence of head and thorax abundant, erect, white; vertex very broad; mandibles entirely black; legs black, with black hair (white on first four femora), hind femora slightly bluish; abdomen short and broad, with white hair on first segment, on the others mixed black and white; sixth segment reflexed, entire. Hind tibial spurs black, strongly

curved at tips; eyes perfectly black; cheeks and sides of vertex with some long black hairs mixed with the pale; tegulæ black, with a slight green tinge; wings slightly dusky, nervures black; second submarginal cell long; anterior edge of clypeus nodulose; clypeus and front as densely punctured as is possible. Mr. Titus adds: "A very distinct species; apical margin of second ventral segment is different from any species heretofore seen. The antennæ are crenulated slightly beneath, and this gives them slight resemblance to males of *lignaria* section, but the species does not belong there. It would be well to note the hairiness of the labial palpal joints 1 and 2."

Osmia chlorops Cockerell and Titus, *n. sp.*

♂. Length about 10 mm., brassy green, with bluish tints on abdomen and thorax; the abdomen shining, the head and thorax densely punctured; pubescence white, long and abundant on face; legs strongly tinged with green. Head large, face almost golden; eyes (in life) green, black anteriorly; mandibles black; antennæ long, black, crenulated; first joint of flagellum covered with a seal-brown velvety pile; tegulæ with greenish punctured margins; wings somewhat dusky; hind tarsi with the basal joint broadened distally, and covered on the inner side with short brown-black hair; hind tibial spurs black, curved at tips; sixth dorsal segment of abdomen notched; apical segment deeply and broadly notched; third ventral segment deeply and broadly emarginate, the edges of the emargination fringed with short shining hairs.

NOTES AND LITERATURE.

ZOÖLOGY.

Gardiner's "Maldive and Laccadive Archipelagoes," Part II.[1]— This second part contains ten "reports." The first, by F. F. Laidlaw, deals with the Amphibia and Reptilia. All but one of the species are abundant in Ceylon, and the exception, *Lygosoma albopunctatum*, is a lizard that is widespread in the Oriental region. For most of the species the region in question is near the western limit of its area of distribution. Only two Amphibia are listed, a Rana and a Bufo; four lizards, two Hemidactyli, a Calotes, and the Lygosoma; four snakes; one species of Testudinidæ (Nicoria) and two marine turtles (Chelone).

The Lepidoptera are listed by E. Meyrick. There are sixty-seven species, of which practically all occur also in India or Ceylon. A single species of Notarcha, regarded as new, replaces the widespread *N. multilinealis*.

Mr. A. E. Shipley has enumerated the six species of Echiurodea and nineteen sipunculoidea. The former belong to the genera Bonellia and Thalassema, characteristic of the warm and temperate seas. A new genus of sipunculids, Lithacrosiphon, allied to Aspidosiphon, is described and figured.

The land and fresh-water mollusks are treated by E. A. Smith. He says: "The present collection comprises eight land and two fresh-water forms from the Maldives, and four terrestrial species from the Laccadives, three of which are included among those from the Maldives. The latter group, judging from the collection at hand, does not possess a single indigenous species, all the forms occurring either on the Indian peninsula or in Ceylon or other localities. As many plants are introduced into the islands by foreign vessels, some or all of the Mollusks there may be accounted for by importation. The list includes *Succinea vitrea*, known elsewhere only from Calcutta and Bombay; a new species, *Sitala vagata*, probably

[1] *The Fauna and Geography of the Maldive and Laccadive Archipelagoes*, etc. Edited by J. Stanley Gardiner. Cambridge, University Press, 1902. Vol. i, pt. ii, pp. vi, 119–222, Pls. VI–XIII, Figs. 24–40.

from India; *Euplecta indica*, var. *malabarica*, found on the adjacent Malabar coast; *Xestina bombayana*, agreeing "in all respects with those from the mainland of India"; *Rhachis punctatus* and *Opeas gracilis*, which are resistant forms associated with plants, with which they may be transported; *Tornatellina manilensis; Melampus castaneus*, from the shore, a wide ranging species; *Leptopomoides halophilus; Melania tuberculata*, found from Syria to Australia and West Africa; and *Cyrena ceylonica*, of mangrove swamps.

The pigments of corals have been investigated by Dr. MacMunn, who finds them "either chlorophylloid or of a closely connected kind of pigment, which latter absorbs the violet end of the spectrum and seems generally changeable into the next kind by the agency of heat, etc., namely, into the dark pigment which gives the coral its dark color in the fresh condition."

The sixteen species of Chætognatha are treated by L. Doncaster. In his consideration of the variation and distribution of the group he makes many interesting points. He lays stress on the fact that since closely allied species are found living together without barrier of habitat, they can hardly have arisen through natural selection; [but it must not be forgotten that there are others than *spacial* barriers]. Remarkable is the occurrence here of a species (*Sagitta flaccida*) previously described only by Conant from the Bahamas.

The six dragon flies are listed by F. F. Laidlaw. One seems to be new, the others are well known Ceylon and Indian species, or have a wider distribution.

The first installment of a series of papers on marine crustaceans is given by L. A. Borradaile. He here considers the Portunidæ, a family that "is highly variable and varietal [exhibiting varieties] and is probably undergoing rapid evolution in many directions." The account of each species is accompanied by valuable notes on its variation.

The longest contribution is by Gardiner, continuing his account of the coral formation of the islands. It is clear and interesting. He assumes, first of all, the former existence of a continent connecting India and Madagascar, which underwent subsidence, leaving certain elevations where mountain peaks were. The archipelagoes occupy the position of one or two of these mountains. Second, the mountains became eroded by the action of oceanic currents to nearly level plateaux two hundred fathoms below the surface. Third, upon these plateaux there began to grow *deep sea* corals, assisted by nullipores and other organisms. By growing on the skeletons of their ancestors

these corals formed banks up to forty or fifty fathoms, at which height the true reef-building corals were able to attach themselves. In time they gained the supremacy and built up the reef to near the surface. A lagoon was formed in the center of the reef partly by the more rapid growth of the organisms on the edge of the bank and partly by the subsequent solution of the central parts. This article is well illustrated by charts and diagrams. C. B. D.

Jordan and Heath's "Animal Forms."[1] — This "second book of zoölogy" is the companion volume of the already well-known *Animal Life* by Jordan and Kellogg, and the two books may be obtained separately or bound together in one volume with the title *Animals*. Whereas the first volume, *Animal Life*, dealt with animal ecology, the second book gives an elementary account of animal morphology. The introductory chapters deal with the differences between animals and plants, the characteristics of an animal as exemplified by a mammal, and the cell and protoplasm. Then follows an examination of typical representatives of the great groups, from the simplest to the most complex. While animals are here considered primarily from the morphological viewpoint, considerable attention is given to functions of organs and to habits and life histories.

Animal Life was designed for the first half year in zoölogy in the high school, and *Animal Forms* to complete a full year's work. However, *Animal Forms* may be used alone or as the first book.

With regard to the adaptability of the book to the conditions obtaining in secondary schools, *Animal Forms* and its companion volume are unquestionably the best existing books for supplementary reading for the high-school beginners; but as a *basis* for an elementary course they are far from practicable, for it will be difficult to follow either book in close correlation with laboratory study. In spite of the authors' emphasis upon "a basis of observation," there has already been manifested in the use of *Animal Life* in some schools a tendency to drift backward towards the old-time recitation method. The informational side of zoölogical teaching must not be allowed to displace scientific training, and a definite laboratory course, and not a text-book, must give the foundation, to which may be added supplemental and closely correlated reading. As sources for such collateral information from which high-school teachers may select topics relating to the laboratory study, *Animal Forms* and *Animal*

[1] Jordan, David Starr, and Heath, Harold. New York, Appleton, 1902. 8vo, vi + 258 pp., 140 figs.

Life deserve the highest commendation, and every pupil in elementary zoölogy should be made familiar with them.

A laboratory manual to accompany *Animal Forms* is announced as in preparation. This perhaps will throw some light upon the problem of correlation between laboratory work and the use of the text.

Aside from the secondary schools, where undoubtedly the books will have the greatest sale, the combined volume, *Animals*, will offer a mine of information and inspiration to college students who use it for collateral reading. Moreover, it should be especially recommended to the growing body of readers who eagerly seek general books relating to animal life.

M. A. B.

BOTANY.

Notes. — Late numbers of the *Botanical Gazette* contain a descriptive list of the plants collected by Dr. F. E. Blaisdell at Nome City, Alaska, prepared by Miss Eastwood. One hundred and seventy species are recorded, several of them considered as new to science.

In the *Bulletin of the Torrey Club* for February Miss Eastwood describes and figures a number of new Californian anthophytes.

Dr. Rydberg's "Studies on the Rocky Mountain Flora," VII, in the March *Bulletin of the Torrey Club*, contains a number of new Ranunculaceæ, Papaveraceæ, and Fumariaceæ.

In No. 4 of the current volume of *Transactions of the Academy of Science of St. Louis*, Professor Norton discusses the unexplored botanical regions of the Southwest, and describes and figures a number of new spermatophytes.

Several southwestern plants are named by Cockerell in *Torreya* for March.

Several new species of trees from the Eastern and Southern States are described by Ashe in the March number of the *Botanical Gazette*.

Fifty additions to the "Catalogue of Ohio Plants" are made by Kellerman in the *Ohio Naturalist* for December last.

A list of the climbing plants of Ohio is published by Miss Dufour in the *Ohio Naturalist* for February.

Dr. Harshberger gives an account of a botanical ascent of Mt. Katahdin, Maine, in the *Plant World* for February. The article is illustrated by half tones and zonal diagrams.

In Vol. LIII, Part III, of the *Proceedings of the Academy of Natural Sciences of Philadelphia*, Dr. Harshberger has an illustrated paper on the ecology of the San Domingo flora.

Vol. XX of the *Acta Horti Petropolitani* consists of the first part of a "Flora Manshuriæ" by V. L. Komarov, occupied with about one hundred pages of bibliography and discussion, in Russian, followed by the pteridophytes and monocotyledons as far as the Orchidaceæ.

Hemsley and Pearson publish, in No. 224 of the *Journal of the Linnean Society* (Botany), an account of what is known of the flora of Tibet.

A paper by Willis and Gardiner, on the botany of the Maldive Islands, is published in Vol. I, Part II, of the *Annals of the Royal Botanic Gardens, Peradeniya.*

In the opening number of the current volume of *Nyt Magazin for Naturvidenskaberne*, Prof. N. Wille contrasts the present vegetation of the Norwegian district of Telemarken with the records for the same district published by H. J. Wille in 1786.

A very interesting detailed study of rheotropism, by Professor Newcombe, presented at the Chicago meetings of last winter, has been published in the *Botanical Gazette.*

Mendel's laws of inheritance in hybrids and crossbreeds are discussed by Weldon in *Biometrika* for January, and by Correns in Heft 3 of the current volume of *Berichte der deutschen botanischen Gesellschaft.*

An illustrated article on caprification as practiced in Algeria, appears in the January number of the *Revue horticole de l'Algérie.*

The self-pruning of plants forms the subject of an article by Schaffner in the *Ohio Naturalist* for January.

Photosynthesis is being passed in review by André Richter in current numbers of the *Revue générale de botanique.*

A portrait of the Spanish botanist Colmeiro, with biography, is published by Lázaro e Ibiza in Vol. XXX of the *Anales de la Sociedad Española de Historia Natural.*

A portrait of Alvah A. Eaton forms the frontispiece to the April number of the *Fern Bulletin.*

A portrait of von Heldreich appears on the first page of the *Deutsche botanische Monatsschrift* for March.

Livraison 2 of the current volume of the *Bulletin du Jardin impériale de St.-Pétersbourg* contains a portrait of the late Dr. J. Klinge.

In the double number (149–150) of the *Bulletin de l'Académie Internationale de Géographie Botanique* is published an excellent portrait of the veteran Chilian botanist, R. A. Philippi, accompanied by a list of his publications, numbering two hundred and twenty-six entries.

A short biographical sketch of Schweinitz, with portrait, is published by Mr. Shear in the *Plant World* for March.

Vol. II of Radde's *Die Sammlungen des kaukasischen Museums*, published in Tiflis, contains twelve portraits and a considerable number of plates and maps.

Lamarck's herbarium forms the subject of an article by Bonnet in the *Journal de botanique* for April.

Dr. Harshberger has an article on the botanical gardens of Jamaica, in the *Plant World* for March.

Vegetable pathology, and the method of teaching it as practiced in St. Louis, are discussed by Dr. von Schrenk, of the Shaw School of Botany, in the *Bulletin of the Torrey Botanical Club* for February.

Professor Marshall-Ward considers predisposition and immunity, in plant diseases, in Vol. XI, Part V, of the *Proceedings of the Cambridge Philosophical Society*.

In the labels for his exsiccatæ of Ohio fungi, reprinted in current numbers of the *Ohio Naturalist*, Professor Kellerman gives transcripts of the original descriptions of the species.

Kellerman and Jennings, in the *Ohio Naturalist* for April, give details of experiments to test the comparative susceptibility of maize and sorghum to Cintractia when taken from different hosts.

Fusarium Lini and the "flax-wilt" that it causes are the subject of *Bulletin No. 50* of the North Dakota Experiment Station.

Papers on fungi, by Peck, Salmon, and Long, are published in the *Bulletin of the Torrey Botanical Club* for February.

The ascomycetous genera Urnula and Geopyxis are considered by Miss Kupfer in the *Bulletin of the Torrey Botanical Club* for March.

Current numbers of *Torreya* contain keys to the species of a number of genera of agarics, by Earle.

The *Botanical Gazette* for July contains the following articles: Arthur, "Uredineæ occurring upon Phragmites, Spartina, and Arundinaria in America"; Nelson, "Contributions from the Rocky

Mountain Herbarium," III; Atkinson, "Three New Genera of the Higher Fungi"; Berry, "Notes on the Phylogeny of Liriodendron"; Cook, "Polyembryony in Ginkgo"; von Schrenk, "Root Rot of Apple Trees caused by *Thelephora Galactina*"; and Wilcox, "*Stipa Hassei* not a good species."

The *Bulletin of the Torrey Botanical Club* for June contains the following articles: Kirkwood and Gies, "Chemical Studies of the Cocoanut, with some Notes on the Changes during Germination"; Curtis, "Some Observations on Transpiration"; Peirce, "Forcible Discharge of the Antherozoids in *Asterella Californica*"; Harper, "*Taxodium distichum* and Related Species, with Notes on some Geological Factors influencing their Distribution"; Nelson, "New Plants from Wyoming," XIV; Wight, "The Genus Eritrichum in North America."

The *Annals of Botany* for June contains the following articles: Yapp, "Two Malayan 'Myrmecophilous' Ferns"; Ward, "On the Relations between Host and Parasite in the Bromes and their Brown Rust, *Puccinia dispersa*"; Hill, "On Variation in the Flowers of Certain Species of Primula"; Copeland, "The Mechanism of Stomata"; Thiselton-Dyer, "Morphological Notes," VII; Farmer and Hill, "On the Arrangement and Structure of the Vascular Strands in *Angiopteris evecta* and some other Marattiaceæ"; and Fritsch, "Algological Notes."

Vol. XXIII of the *Transactions of the American Microscopical Society*, issued in May, contains the following botanical articles: Jackson, "A New Species of Crenothrix (*C. manganifera*)"; and Bessey, "Structure and Classification of the Conjugatæ, with a Revision of the Families and a Rearrangement of the North American Genera."

Heft 9 of Engler's *Das Pflanzenreich*, a volume of 438 pages, with numerous figures, is a revision of Myrsinaceæ by Mez, and bears date May 6, 1902.

A revision of Conocephalus, by Bargagli-Petrucci, is a prominent feature of the *Nuovo Giornale Botanico Italiano* for April.

A revision of the Podostemaceæ of India and Ceylon, by Willis, appears in Part III of the *Annals of the Royal Botanic Gardens, Peradeniya*, issued in May.

The laws of plant distribution in alpine regions are analyzed by Jaccard in *Flora* of April 30.

An interesting addition to the botany of the Atlantic islands is a comparative account of the mosses of the Azores, Madeira, and the

Canaries, published, in connection with an article on some mosses of the latter islands, by Cardot, in No. 5 of the *Bulletin de l'Herbier Boissier* for the present year.

No. 10 of Marcus E. Jones's *Contributions to Western Botany*, issued as an individual publication by the author from the Mammoth Record Print of Robinson, Utah, under date of June 1, 1902, contains a revision of the Alliums of the Great Basin region, with notes on the markings of the bulbs and a key to the species based on them; further notes on Astragalus; a study of the Nyctaginaceæ, chiefly of the region of the Great Plateau; and descriptive or synonymic notes on a number of miscellaneous species.

The flora of Scott and Muscatine counties, Iowa, is the subject of a paper by Barnes, Reppert, and Miller, in the recently issued eighth volume of *Proceedings of the Davenport Academy of Sciences.*

A botanical series of the *University of California Publications* begins with the issuance, under date of June 7, of a paper by H. M. Hall, entitled "A Botanical Survey of San Jacinto Mountain." It appears to be a well done piece of work, on the prevalent ecological lines, and is well illustrated.

A catalogue of British marine algæ, by Batters, is in course of publication as a supplement to current numbers of the *Journal of Botany.*

A large part of Vol. III, fasc. 3–6, of *Le Botaniste*, dated June 10, is occupied by a paper on Euglenia, by Dangeard.

Cladophora, as represented in the salt water of New England, — a difficult group, — is revised by Collins, in *Rhodora* for June.

Studies of spore germination in the common mushroom and other agarics, by Miss Ferguson, form *Bulletin No. 16* of the Bureau of Plant Industry of the national Department of Agriculture.

The Geastreæ of the United States are revised in an illustrated paper by C. G. Lloyd, forming *Bulletin No. 5* (mycological series, No. 2) of the Lloyd Library.

In the *Journal of Botany* for June, Arthur Lister describes and figures a Chondrioderma, — *C. asteroides*, — which in aspect resembles to a marked degree a small Geaster.

The *Technology Quarterly* for June contains an article by Whipple on the physical properties of gelatin, with reference to its use in culture-media.

A paper on albino phenomena in the vegetable kingdom, by Pantanelli, is published in Nos. 10–12 of Vol. XV of *Malpighia.*

An account of double fertilization in *Monotropa uniflora* is published by Shibata in *Flora* of December 4 last.

In the *Journal de Botanique* for May, Guignard has an article on double fertilization in Solanaceæ.

The mechanism of secretion of extra-floral nectaries is the subject of an article by Haupt in *Flora*, Vol. XC, Heft 1, which also contains a paper by Lepeschkin on the significance of the water-secreting organs of plants.

Meierhofer has a well illustrated article on the bladders of Utricularia in *Flora* of Dec. 4, 1901, which also contains a paper by Brenner on climate and leaf form in Quercus, and an extensive study of Gunnera by Schnegg.

An account of the developmental history of Quercus is given by Brenner in Vol. XC, Heft 3, of *Flora*.

An important addition to the literature of plant physiology, in its economic bearings, is Dr. Whitten's thesis on "Das Verhältnis der Farbe zur Tötung von Pfirsichknospen durch Winterfrost," recently published in Halle.

A handbook of the economic plant products of Ceylon, by Willis and Wright, is in course of publication as supplements to current numbers of the *Annals* of the Peradeniya garden.

An interesting account of the fiber Agaves, by Marshall, is reprinted from the *Journal of Geography* in the *American Journal of Pharmacy* for July.

An illustrated account of the new botanical laboratories at Liverpool is contained in *Nature* for June 12.

Several views of the Cape Town Municipal Gardens are published in the *Gardeners' Chronicle* of June 7.

A portrait of J. B. Ellis forms the frontispiece of No. 62 of the *Journal of Mycology*.

A memorial of the Italian botanist Gibelli is separately issued from Vol. XIV of *Malpighia*.

A biographic sketch of Ramírez, with portrait, is published in the *Memorias y revista de la Sociedad Cientifica "Antonio Alzate"* of October last.

In *Biometrika* for April, Mr. Yule has a paper on the variation of the number of sepals in *Anemone nemorosa*, and Mr. Tower a paper on the variation in the ray flowers of *Chrysanthemum leucanthemum*, on which subject is added a further note by Pearson and Yule.

An editorial in the same number of *Biometrika* contains some desirable cautions as to the polymorphism of certain species which appears to result from the frequency polygons derived from tabulated individual measurements.

The first fascicle of Vol. III of the *Contribuzioni alla biologia vegetale* of the *R. Istituto botanico di Palermo* contains the following papers of general interest: Terracciano, "Contributo alla biologia della propagazione agamica nelle fanerogame"; Albo, "Sul significato fisiologico della nicotina nelle piante di tabacco"; La Floresta, "Formazione di radici avventizie nelle foglie di *Gasteria acinacifolia*"; Borzí, "Anatomia dell' apparato senso-motore dei cirri delle Cucurbitacee"; and La Floresta, "Struttura ed accrescimento secondario del fusto di Xanthorrhoea." The articles are well illustrated and a French résumé is given of their contents.

Rhodora for June contains the following articles: Collins, "Marine Cladophoras of New England"; Nye, H. A., "Blooming of Hepaticas"; Brainerd, "Two more Rare Plants from Lake St. John, Quebec"; Blanchard, "Some Vermont and New Hampshire Plants in the Middle Connecticut Valley," I; Fernald, "The Seneca Snakeroot in Maine"; Webster, "*Clathrus columnatus* in Lawrence, Mass."; Robinson, "Two New Hypericums of the Adpressum Group"; and Fernald, "An Anomalous Skullcap."

The third *Report of the Michigan Academy of Science* contains the following botanical articles: Pollock, "Relation of the Fibro-Vascular Bundles in the Root and Hypocotyl in *Echinocystis lobata*"; Reed, "Ecology of a Glacial Lake"; Larsen, "Disease of the White Birch"; Denton, "Interfoliar Scales of Monocotyledonous Aquatics"; Clark, "Notes on the Flora of Eaton County"; Davis, "Notes on *Utricularia cornuta*"; Davis, "Wolffia Notes"; Longyear, "Notes on Michigan Saprophytic Fungi"; Longyear, "New Species of Michigan Fungi"; Longyear, "Sclerotium Disease of the Huckleberry"; and Conover, "*Asparagus plumosus*."

The *Botanical Gazette* for May contains the following articles: Miyaké, "On the Starch of Evergreen Leaves and its Relation to Photosynthesis during the Winter"; Newcombe, "Rheotropism of Roots" (conclusion); Overton, "Parthenogenesis in *Thalictrum purpurascens*"; Leavitt, "Subterranean Plants of Epiphegus"; Fairchild, "Notes of Travel," VIII; Cockerell, "A New Heliotropium (*H. xerophilum*)."

The *Botanical Gazette* for June contains the following articles: Rimbach, "Physiological Observations on the Subterranean Organs of some Californian Liliaceæ"; Smith, "The Parasitism of *Botrytis cinerea*"; Shaw, "The Development of Vegetation in the Morainal Depressions of the Vicinity of Woods Hole"; Webb, "A Morphological Study of the Flower and Embryo of Spiræa"; Fairchild, D. G., "A Precocious Poplar Branch"; and Wilcox, "Numerical Variation of the Ray Flowers of Compositæ."

Botanical papers in No. 7 of the *Bulletin of the New York Botanical Garden* are: Earle, "Mycological Studies," I; Williams, "A Preliminary List of Montana Mosses"; and Hollick, "Geological and Botanical Notes, Cape Cod and Chappaquidick Island, Mass."

Torreya for June contains the following botanical articles: Rydberg, "Our Yellow Lady's-Slippers"; Underwood, "The Bracket Fungi"; Lloyd, "An Interesting Irregularity in a Rose Flower"; and Britton, E. G., "Notes on a Long Island Moss."

The *Bulletin of the Torrey Botanical Club* for May is entirely occupied with Cryptogams, mostly fungi.

Botanical articles in the *Ohio Naturalist* for June are: Kellerman and Tyler, "Further Additions to the Catalogue of Ohio Plants"; Dresbach, "Moulds Injurious to Foods"; and Tyler, "Rosette Plants of Ohio."

A large part of Engler's *Botanische Jahrbücher* continues to be occupied with descriptions of African plants.

As usual with the *Journal of the Royal Horticultural Society*, the number for April contains several articles of general botanical interest.

After an intermission of eight years, the *Journal of Mycology* begins its eighth volume with No. 61, bearing date May, 1902.

The great multiplication of species in Cratægus is commented on by Professor Bessey in *Science* for May 16.

A paper by Knuth on the geographic distribution, adaptive structure, and classification of the species of Geranium, is published in Engler's *Botanische Jahrbücher* of May 2.

A monograph of the Senecios of North and Central America, by Dr. Greenman, is published as a contribution from the laboratory of the Berlin Garden, in the first Heft for the current year of Engler's *Botanische Jahrbücher*. Keys are given to the sections, under each of which are enumerated the species recognized as belonging to it.

Dr. Holm has an article on the grass genus Arctophila Rupr. in the *Ottawa Naturalist* for June. Three new species are described.

An analytical key to the ferns of the northeastern states, based on stipe characters, by C. E. Waters, is printed in the *Johns Hopkins University Circular* for June.

A lecture on the past, present, and future of vegetable pathology, by Dr. G. Mottareale, is reprinted from *Italia Orticola* for March to May.

In *Education* for February, Dr. Harshberger discusses the question as to what part of the varied things comprised in "botany" is of most worth.

In *Popular Science News* for June, G. W. Browning has an illustrated article on insect-catching plants, other than those that are carnivorous.

Spindle formation in Agave is the title of a cytological paper by Osterhout, published as No. 8 of the current volume of *Proceedings of the California Academy of Sciences.*

An interesting note on the formation of hair masses in the stomachs of goats that have fed on the fruits of the sweetbrier rose is published by Sir William Thiselton-Dyer in *Nature* for May 8.

A study of galls and the insects producing them, by M. T. Cook, appears in No. 7 of the *Ohio Naturalist,* and is separately printed as a bulletin of the University of Ohio.

Professor Brewer has distributed separates of an article on the relation of forestry to public health, from the *Proceedings of the Twenty-Ninth Meeting of the American Public Health Association.*

The decorative possibilities of some native climbers are shown by Professor Nelson in *Bulletin No. 50 of the Wyoming Experiment Station.*

The *Revue horticole* for June 1 contains an illustrated article on the botanic garden of St. Pierre before its destruction by the eruption of Mont Pelée.

An account of the botanico-geographic regions of North America, as exemplified in the new botanical garden at Dahlem-Steglitz, is given by Professor Engler in Appendix IX of the *Notizblatt des K. Botanischen Gartens und Museums zu Berlin,* dated May 15, 1902.

Several new or little known Southern California plants form the subject of a note by LeRoy Abrams in No. 6 of the current volume of the *Bulletin of the Southern California Academy of Sciences.*

Parts III and IV of Spegazzini's "Nova addenda ad floram Patagonicam," separately issued from the *Anales del Museo Nacional de Buenos Aires*, Vol. VII, bears date of April 16, and includes species numbered from 474 to 977 inclusive, — a considerable number of them being new.

Visitors to the beautiful little island of Capri, in the Gulf of Naples, will find help in a study of its flora in a tasteful little handbook by Cerio and Bellini, entitled *Flora dell' Isola di Capri*, published by Emilio Prass of Naples.

A portrait and biographical sketch of Dr. Adam Kuhn, first professor of botany in America and at the University of Pennsylvania, with an illustration of the genus Kuhnia, named in his honor, are published by Dr. Harshberger in the *Alumni Register*, of Philadelphia, for April.

A portrait of Sir George King, formerly director of the Calcutta Garden, is published in the *Gardeners' Chronicle* of May 11.

A note on Parkinson, with figure of the Parkinson statue in the palm house at Sefton Park, Liverpool, is printed in the *Gardeners' Chronicle* for May 17.

CORRESPONDENCE.

Editor of the American Naturalist:

Mr. Robertson's criticisms in the *American Naturalist* for July appear to be exceedingly captious and trivial. In my paper on the colors of flowers I say of the visitors of *Nymphæa advena*, "I have collected on the flowers in Maine four Diptera, two Coleoptera, and one small bee, *Halictus nelumbonis*, which confines its visits to this flower." So far as possible my remarks on the visits of insects to flowers are based on numerous observations I have made in the field. The above remark is true of this bee, so far as I have collected it, in this locality.

Again, as to the number of visitors to the Umbelliferæ. It is certainly true that several species are visited by more than two hundred insects, while others approach quite closely to this number. I still believe that when a more careful and extended study of these plants shall have been made, the number of visitors to many species will be found to exceed two hundred. The visitors to many umbellifers have, moreover, never been collected.

As regards the visits of beetles to dull yellow flowers, it certainly never occurred to me that there was anything in my paper which could lead any reader to believe that I considered the statement as new. I mentioned the later observations of Müller, and also those of Loew, Schultz, and Knuth, as well as one of my own, and added that it did not appear necessary to carry the illustrations further. In the brief reviews of the coloring of the different plant families which space renders possible, I am compelled to omit many observations both of my own and of others. Mr. Robertson tells us that he has also made some observations on this subject, and the real animus of his remarks seems to be that he has been hurt because no reference was made to these. Mr. Robertson was not long ago severely censured by a correspondent of the *Canadian Entomologist* for his loose way of naming supposed new species of bees based on single specimens or on trivial characters. Of his regard for the rights of others a single illustration will serve. In the *Transactions of the Academy of Science, St. Louis*, Vol. X, No. 2, p. 48, after describing *Andrena viciniformis*, which he calls a new species,

he adds, "This may be the same as *A. dunningii*." A comparison of the two descriptions will leave little doubt that the species are identical. In renaming *A. dunningii* an injustice is done both to the author of this species and to the person in whose honor it was named. Again, in the *Canadian Entomologist*, Vol. XXXIII, No. 8, p. 231, he writes: "*Epeolus lectoides* n. sp. ♀. — Closely resembles *E. lectus* Cr., and may be the same." Described from one specimen. Additional instances might easily be given. An author who will publish such descriptions as these certainly shows little desire for the advancement of the interests of science.

JOHN H. LOVELL.

WALDOBORO, MAINE, August 11, 1902.

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BEDDARD, F. E. Mammalia. The Cambridge Natural History. Vol. x. 8vo, xii + 605 pp., 285 figs. $4.00. — BLAISDELL, A. F. Life and Health. A Text-Book on Physiology for High Schools, Academies, and Normal Schools. Boston, Ginn & Co., 1902. 8vo, vi + 346 pp., 110 figs. — DAVIS, W. M. Elementary Physical Geography. Boston, Ginn & Co., 1902. 8vo, xviii + 401 pp., 190 figs., 9 pls. — EMERTON, J. H. The Common Spiders of the United States. Boston, Ginn & Co., 1902. 8vo, xviii + 225 pp., 501 figs. $1.50. — GARDINER, J. S. The Fauna and Geography of the Maldive and Laccadive Archipelagoes, etc. Vol. i, pt. ii. pp. vi, 119–222, Pls. VI–XIII. — GILBERT, J. K., and BRIGHAM, A. P. An Introduction to Physical Geography. New York, Appleton, 1902. 8vo, xvi + 380 pp., 263 figs. — JORDAN, D. S., and EVERMANN, B. W. American Food and Game Fishes. A Popular Account of all the Species found in America North of the Equator, with Keys for Ready Identification, Life Histories, and Methods of Capture. New York, Doubleday, Page & Co., 1902. 8vo, l + 573 pp., colored plates, text figures, and photographs. $4.00. — JORDAN, D. S., and HEATH, H. Animal Farms. A Second Book of Zoölogy. New York, Appleton, 1902. 8vo, vii + 258 pp., 140 figs. — RABL, CARL. Die Entwicklung des Gesichtes. Tafeln zur Entwicklungsgeschichte der äusseren Körperform der Wirbelthiere. I. Heft, Das Gesicht der Säugethiere, I, (Kaninchen, Schwein, Mensch). Leipzig, Engelmann, 1902. vi + 21 pp. folio, 8 pls. 12 marks. — ROOSEVELT, THEO., VAN DYKE, T. S., ELLIOT, D. S., and STONE, A. G. The Deer Family. New York, Macmillan, 1902. 8vo, ix + 334 pp., 21 pls., 5 maps. $2.00. — SAGE, D., TOWNSEND, C. H., SMITH, H. M., and HARRIS, W. C. Salmon and Trout. New York, Macmillan, 1902. 8vo, x + 417 pp., 20 pls, 13 figs. — SANDYS, E., and VAN DYKE, T. S. Upland Game Birds. New York, Macmillan, 1902. 8vo, vii + 429 pp., 9 pls. — SMITH, EUGENE. The Home Aquarium and How to Care for It. A Guide to its Fishes, Other Animals, and Plants, etc. New York, Dutton, 1902. 8vo, ix + 213 pp., 137 figs. $1.20. — WHEELOCK, IRENE GROSVENOR. Nestlings of Forest and Marsh. Chicago, McClurg, 1902. 8vo, xvi + 257 pp., 22 pls., text figs.

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